Identification of Significant Marine and Coastal Areas in the Bay of Fundy

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by

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ABSTRACT

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This document presents a summary of significant[1] marine and coastal areas in the Bay of Fundy, as defined in this document by:

> [1]their ecological significance, their high biodiversity, their educational or scientific importance, or their social or spiritual value. It also includes areas proposed by various studies as requiring special management or as potential marine protected areas.

With the many pressures on our ecosystem it is essential to identify these areas and ascertain those that may require special protection or immediate attention. The identification of these important sites can provide some of the groundwork towards Integrated Management of coastal waters, and the incorporation of Marine Protected Areas within a management area.

Significant[1] sites were identified through the scientific literature, or by academic and local experts. Effort has been made to include local or traditional knowledge, along with scientific data, through a series of workshops. It is hoped that this document will promote participation and input into Integrated Management by coastal communities, and be seen as the first of a series of updates that will continue to include more data and public knowledge.

The report contains a summary of existing information for each site, presented as a series of maps. Also included are the proceedings of information gathered through workshops.

RÉSUMÉ

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Le présent document donne un aperçu des habitats marins et des zones côtières importants[1] de la baie de Fundy en fonction de:

> [1]leur importance écologique, leur grande biodiversité, leur importance éducative ou scientifique ou encore leur valeur sociale ou spirituelle. Cela comprend les zones dont diverses études proposent une gestion particulière ou celles qui pourraient devenir des zones de protection marines.

En raison des nombreuses pressions que subit notre écosystème, il est essential d'identifier ces zones et de déterminer quelles sont celles qui sont susceptibles de nécessiter une protection spéciale ou une attention immédiate. L'identification de ces zones importantes peut représenter une partie du travail de base pour la gestion intégrée des eaux côtières et l'intégration de zones de protection marines au sein d'une zone de gestion.

Les habitats importants[1] ont été identifiées par des experts universitaires et locaux ou en fonction d'ouvrages scientifiques. On s'est efforcé d'intégrer au processus les connaissances locales ou traditionnelles, ainsi que les données scientifiques, dans le cadre d'une série d'ateliers. On espère que le présent document servira à promouvoir la participation et la contribution des communautés côtières à la gestion intégrée, et qu'il sera considéré comme le premier d'une série qui présentera de plus en plus de données et de connaissances publiques.

Le rapport résume l'information dont on dispose sur chaque zone et présente des cartes. On y trouvera aussi un compte rendu de l'information exposée lors des ateliers.

A - INTRODUCTION

"Some areas are especially important" (E. Norse, 1993).

> The term "significant[1] areas" is used here to summarize the reasons associated with an area's ecological significance, vulnerability or sensitivity to human activities, high biodiversity, educational or scientific importance, or social or spiritual value. It also includes areas proposed by various studies as requiring special management or as potential marine protected areas.

The terminology assigned to the list of areas identified in this report might lead the reader to focus on the appropriateness of the use of the term significant[1], and whether it, or other terms such as "critical," "sensitive, " or "important," should have been used. This report focuses on identifying significant[1] areas as defined above, a definition derived from a compilation of similar reports found in the literature.

World-wide recognition is given to the significance of estuaries and coastal waters, and these are often the areas identified in studies prioritizing pollution hotspots (Anon, 1999). Chamura (*In* Bert, 1997) identified salt marshed in New Brunswick and Maine as Regionally Significant Habitats. Areas are deemed sensitive by the United Nations Environment Programme if they are at higher risk to suffer negative impacts from human activities. The International Maritime Organization (IMO) recognizes "sensitive sea areas" for their ecological or socio-economic importance, and focuses on the prevention of marine pollution in these areas due to shipping traffic (Eichbaum et al., 1996). Westwater (1993, *In* Child and Millar, 1997) applies three criteria to define Environmentally Sensitive Areas (ESAs):

- Uniqueness: areas supporting rare or endangered species
- Ecological significance: areas that maintain or support ecological structure and processes
- Vulnerability: habitat or species vulnerable to human activities

In the evaluation of sensitive areas in the Turner Creek, BC area, Child (1997) gave the highest ESA rating to marshes (hydrological regime and vulnerability), and wildlife corridors (ecological significance). Rachor (1980) identified areas of soft muddy sediment as sensitive, because studies have shown that the majority of the infauna are susceptible to environmental stress, and that an impoverishment trend that results from the introduction of wastes leads to a shift on community population dynamics. The result is a change in that community towards organisms adapted to decomposition of additional wastes. The increase in abundance of deposit feeding organisms, and the elimination of subsurface species, is regarded as an indication of increased organic input (Pearson and Rosenberg, 1978).

The International Union for the Conservation of Nature (IUCN, 1988) defined criteria for protecting and managing marine resources according to their ecological importance. This criteria would refer to a site that: contributes to ecological processes; contains a variety of habitats, or is representative of some; contains a threatened or endangered species; is a juvenile, nursery or spawning area; contains rare or unique habitat; or is genetically or species diverse.

In a literature review for sensitive areas of the MacKenzie River system, British Columbia (Anon, 1981), a Task Force identified thirty-seven sensitive areas within a proposed hydroelectric development. It outlined all the information available for each, in order for the Task Force to decide if each site might be expected to suffer serious damage. The ecological criteria imposed for identification of those sites was that they should be *"unique sites, or of particular importance because of its biological productivity, or cultural and social value."*

Owens (1977) ranks the sensitivity of the different habitat types in terms of an oil spill. The most sensitive areas, Group I (marshes and lagoons) being those in which oil is most likely to collect and persist. Group II (sheltered environments and pocket beaches) are slightly less likely to be affected. Group III (exposed beaches, mudflats and sand flats) would have higher degradation rates. Group IV (exposed rock or cliffs) would generally not require protection or clean up and degradation is high.

The term "critical area" is most often associated with the sensitivity of an area as related to habitat requirements of a marine species of commercial value, and is defined in the *Fisheries Act*, Section 34(1). Messieh (1992) describes critical habitats as sensitive, vulnerable, and unique areas, which are vital to a life stage of a marine species (such as spawning), and where nutrients and physical conditions are favourable for these stages. Critical habitat is also associated with the habitat required by endangered species. However, Messieh also suggests that critical areas include those that supply nutrients to the oceans, such as marshes, estuaries, coastal areas, upwellings, and "transient" features of a water mass that shift with tide and season. But the definition of critical habitat will also be different according to perspective. It could be argued that all areas of the sea are critical to something. Overall, reports tend to overlap definitions used, and may even subdivide habitats into critical or important (Burt 1997). Most of the definitions focus on anthropogenic values, such as significant habitat for an important life stage of a commercial species (Therrien et al. 2001).

Results of discussions at the Marine Protected Areas session of Coastal Zone Canada 2000, suggest that sites of interest to the communities are unique areas, critical habitats, areas important to shorebirds, and areas of traditional fisheries. Local or community based knowledge was felt to be critical in these issues, and that often locals would be the first to recognize the importance of a coastal area (Boyd, in Chopin and Wells, 2000).

However, each of the above definitions does not capture all the areas that were identified by our search, some of which have little scientific data available to categorize them. As well, some important criteria listed in the *Oceans Act*, such as high biodiversity, habitat of non-commercial species, and areas required for research, monitoring, and education, would not be included by the definitions found in the literature. Therefore, we have used a very inclusive definition for significant[1] areas.

This document presents a summary of significant[1] marine and coastal areas in the Bay of Fundy, as defined by their ecological sensitivity, high biodiversity, uniqueness, ecological, educational, and scientific importance, or their social or spiritual value.

What do we want to accomplish with this document?

This document presents material organized as discrete geographic areas, in order to assist with the identification of key areas as groundwork towards Integrated Management of coastal waters and the incorporation of Marine Protected Areas in the Bay of Fundy. This document presents a list of sites acknowledged in the literature, or by various organizations, as significant[1], or as potential marine protected areas.

The majority of the citations describing these areas were found to be subjective in their definitions, with little to no systematic analysis to substantiate the validity of the description given. In this report, we make only an effort to summarize the information, rather than to compare areas, or to rank them.

With the many pressures on our ecosystem, including coastal development, traditional fishing, new industries such as aquaculture and rockweed harvesting, increased habitat destruction, and increase of pollutants, to name but a few, it is essential to identify these areas and ascertain those that may require special protection or management, or that may require immediate attention. For example, Lawton et al. (1995) describe the use of mapping lobster distribution which may identify sensitive fishery areas, and that this information can then be used prior to any aquaculture developments. The identification of these sites can also provide some of the groundwork towards an interim marine protected system plan, consisting of areas that are of biological and social importance, but giving priority to potentially threatened sites first. A system plan would relate individual sites, based on common characteristics, criteria, and objectives. Selection of sites for Marine Protected Area status will require an assessment of their ecological significance, as well as the social and economic impacts. Not all sites will fit the *Oceans Act* criteria; some will require protection under other conservation legislation. However, those that do should be reviewed by applying a set of criteria and through consultation with all interested parties.

Roff and Day (2000) recommend that choosing only distinctive or special areas should not be the primary approach to siting and developing a system of marine protected areas, as these areas will be representative only of those for which information is available, ignoring and potentially excluding other important areas not yet. They stress that there needs to be a systematic and science-based way of choosing sites but that even such a method would not necessarily include all the unique and special marine features that should or need to be protected. They explain that these areas can be identified separately and designed to contribute towards the overall system, even if their contributions are analyzed in hindsight. Support for this dual methodology is found in several public discussions. Here are some extracts from participants at the Coastal Zone Canada 2000 roundtable discussion on Marine Proteced Areas (Buzeta, in Chopin and Wells, 2000):

> *"Comprise a list of sites obtained via any scientific literature available, or sites that others suggest, and bring all potential sites to the table at once for discussion and evaluation as a package."*
>
> *"Identification won't always be scientific, rather scientific information will be used to back up, modify, or retract decisions."*
>
> *"Some spots are known to be 'highly biodiverse' by locals…this would identify them, even if studies are needed later to quantify."*
>
> *"People may feel that a site is worthy of protection but not have the science or the resources to gather the information (summarized as the 'fall in love first, justify later' philosophy)."*
>
> *"Be precautionary by identifying sites to the best of present knowledge, or start with local information for others, at the same time proceed with studies to verify decisions, and modify plan accordingly."*
>
> *"Systematic approach would work in the Arctic or a remote area with few users, but industries aren't waiting here, there are too many users."*

When looking for management options, we should keep in mind the various principles and tools available through the *Oceans Act*: the Ecosystem Principle, the Precautionary Principle, and the tools of Marine Protected Areas and Marine Environmental Quality standards. As well, the National Program of Action (NPA) (June, 2000), which specifically targets land-based impacts on the marine environment, gave the highest rankings to point and non-point sewage control, persistent organic pollutants, shoreline construction/alteration, and wetland and saltmarsh alteration. Actions recommended in the NPA to prevent impacts include increased knowledge of distribution and sensitivity of resources and ecosystems, and the implementation of marine protected areas within integrated management plans. Finally, conservation theory gives some basic rules for environmental management that should be applied to management of coastal waters (Clark, 1977):

- Avoid excessive amounts of nitrogenous substances.
- Avoid any discharge of suspended solids into coastal waters.
- Avoid any significant reduction in oxygen, or change in salinity.
- Avoid discharges of pathogens or toxic substances.
- Avoid alterations or blockages to the natural water flows.
- The more excessive the coastal and marine development, the higher the need for preserving vital (significant[1]) areas.

B - METHODOLOGY

Ecologically significant[1] sites were identified through scientific literature, or suggested by academics and local experts. The information summarized here represents the published literature, and discussions or personal communications with the scientific community, academics and representatives of various agencies and communities. The report presents this information as a series of maps.

Generally, the information summarized does not include resource assessment data available for each commercial species. The authors felt that detailed scientific information on commercial marine species is already documented as part of the Regional Advisory Process. Species distribution information obtained from local knowledge, for some of the more sedentary species such as molluscs, is shown. The focus therefore, is on areas of general ecological importance, including habitat of both commercial and non-commercial species, and on areas critical to certain life stages (ex. juvenile), or life processes (ex. spawning).

Also included are the results of information gathered during workshops that convened community members with local ecological knowledge. Effort has been made to include this knowledge. Many communities and local experts are yet to participate, however the authors feel that discussion should begin on the information collected so far. In addition, it is hoped that this document will promote more participation in the process of coastal management, and be seen as the first of a series of updates that will continue to include more scientific data and public knowledge.

LITERATURE OVERVIEW

Notable overviews of the Bay of Fundy include that of Gordon and Dadswell (1984), on the marine environmental consequences of tidal power; Hunter and Associates (1982), prepared for the New Brunswick Department of Natural Resources for the purpose of documenting information and preparing recommendations for coastal zone management; and Percy et al. (1996), a review of the scientific knowledge for a Bay of Fundy Ecosystem Partnership document.

Small-scale geological information and species assemblages were not found in the literature for many of the sites discussed in this document. Notable exceptions for habitat studies are those of Thomas (1983), in his treatise on the Quoddy region; Logan et al. (1984), for the descriptions of subtidal rocky habitats; MacKay (1975, 1977), and MacKay et al. (1978, 1979), in their transect studies of areas in southwest New Brunswick and Brier Island; and the lobster habitat studies by Lawton (1992) and Lawton et al. (1995). These are good examples of data reported for specific locations, which includes general ecological information, habitat requirements, and distribution, of non-commercial species. The reports by MacKay and MacKay et al. provide details on species identified during spot examinations and transects at several areas around the Bay of Fundy. These areas include: Musquash to Lorneville, Pea Point to Pt. Lepreau, Back

Bay and Letang, the Deer Island-Campobello area, the Grand Manan Archipelago, and Brier Island. From these reports, the number of species (flora and fauna) found at the various locations were plotted. Other studies, such as that of Magee et al. (1999), report on benthic species associated with a commercial fishery. In this case, the epifaunal species occurring on the sea scallop *(Placopecten magellanicus)* were recorded during inshore scallop population surveys. Known scallop grounds in the Lower Bay of Fundy, off Digby, Yarmouth and Brier Island, Nova Scotia, and Grand Manan, New Brunswick, were included in the survey.

WORKSHOPS

After reviewing the literature, and holding discussions during the Coastal Zone Canada 2000 Conference, there was still a need to capture undocumented knowledge from both scientifists and community members. The authors found much useful, yet unpublished, information from community work, student projects, and industry observations.

The Identification of Significant[1] Marine and Coastal Areas Workshops (SAW) were organized so that individuals could participate without travelling a long distance. The workshops were purposefully small and informal, in order to foster discussion. Participants were asked to prepare for the meeting by: summarizing their knowledge of specific sites; documenting their ecological concerns for these sites; filling out a questionnaire (Appendix H) for each site; and referencing any unpublished data, images, or research that may be available for that site. The workshop description (Appendix H) was mailed out as an invitation to fishing organizations, community groups, academic and research institutions, First Nations, Environmental organizations, scientists or individuals, to participate in identifying these areas by attending a workshop, or by making a written submission. Three of the four workshops initially planned around the Bay of Fundy were successfully held at Saint John and Sackville, New Brunswick, and Wolfville, Nova Scotia. Many groups were contacted; many more still should be contacted. It is hoped that the documentation of the workshops so far will promote interest by more groups to participate and share their information.

COLLECTION OF LOCAL INFORMATION

A Community Coastal Resource Mapping project, completed in 1999, summarized a large body of information gathered from local knowledge. Most of that information has been used in this document, when reviewing the site-specific information. Possible exceptions are data that required updating.

There is a considerable body of knowledge gathered by experienced divers, many of which are biologists and educators, or from dive operators whose business it is to know the area and its marine communities. The careful observations of the marine communities they encounter are of use and benefit beyond their original intent (i.e., dive logs). An effort has begun to gather this body of information in a systematic way; some of these observations are referenced in this report.

LOCATIONS (MAP) OF SITES REVIEWED

Mapped information, more specifically geographically referenced (GIS) information, is considered **essential** for answering management questions. The hardcopy maps presented here represent the "workspaces" that are available as a result of this exercise, and which can be used to analyze various layers of information together, and at different geographic scales. Mapping helps visualize critical areas as well as gaps in knowledge for certain locations.

The aggregations of sites used in this report are for mapping purposes only, and are based purely on geographic nearness. Figure C.1 shows the locations of areas discussed in detail in subsequent sections of the document. These aggregations also assist the reader in locating and reviewing the material associated with a site, and in identifying ecological issues or interested parties. There are several examples of division lines drawn within the Bay of Fundy, often based on practical aspects related to sampling methods (sedimentology, benthic infauna, groundfish surveys), or management of resources and users (fisheries, counties). In this report, we make no attempt at defining regions or sectors.

LIMITATIONS

There is an incompleteness of available information for the sites presented. As well, many gaps were identified that may be crucial to formulation of an appropriate Bay of Fundy management plan and system of Marine Protected Areas. A literature search of the Nova Scotia near shore habitats, conducted by the Department of Fisheries and Oceans in 1984, also identified serious data gaps (Messieh, 1992). Work is still ongoing in identifying specific sites in the inner Bay of Fundy and on the Nova Scotia side of the Bay. Subjective observations on ecological importance, even though these may be corroborated by many expert references, are difficult to uphold without the required scientific information, yet in some cases these areas are potentially threatened and in need of proper management.

Benthic Mapping

Recommendations generally suggest that a systematic approach needs to be taken, requiring the oceanographic information for each area, multibeam mapping of the sea floor, surveys of the biota occupying those areas, and the ground-truthing of these data in order to test the applicability of extending that data into areas not studied. All this information would still not allow us to fully understand the ecological significance of each area, and for practical reasons, the entire Bay of Fundy ocean floor is not likely to be mapped in the near future.

Site Specific Data

In this document we have focused in summarizing only the ecological/biological information. Occasional information may have been obtained regarding a site's importance for social or economic reasons. Areas summarized here represent those for which there is information, interest, or data, that suggests "significant[1]." However, the report does not suggest that other areas not represented are less "significant" or ecologically important, merely that our search yielded no information. Also, while some information is available at a very small geographic scale, the majority of fisheries data, sediment and oceanographic information, is at a very large scale. Suggestions on how to overcome these limitations include: long term systematic habitat studies, including video transects, in order to obtain information on community structure; a detailed multibeam and sidescan survey of the Bay; a detailed knowledge of current and circultion of the areas; and a decision-making support system and methodology to answer "significant" questions from new unsurveyed areas.

Geographic Areas

Literature searches yielded much more site-specific information for the New Brunswick side of the Bay of Fundy, than for the Nova Scotia side. This may be the result of a few intense studies associated with specific development projects in the past, or the nearness or accessibility to research facilities.

Public Input

Effort has been made to include local or traditional knowledge, along with the scientific data. This document is seen as the first of a series of updates, or editions, that will continue to include more data and public knowledge, as it becomes available.

Marine Protected Areas System Planning

At this time, a system plan for the Bay of Fundy has not been developed, however this site-specific review will assist in selection once the basis for the plan has been finalized.

C - GENERAL DESCRIPTION OF THE BAY OF FUNDY

The Gulf of Maine, as defined by the Gulf of Maine Council on the Marine Environment, is shown in the insert of Figure C.1. Its coastal boundaries span Cape Cod, Mass. in the south, to Cape Sable, Nova Scotia, and include three States and two Canadian provinces. The Bay of Fundy, as part of the Gulf of Maine, has a generally accepted boundary line from Yarmouth, Nova Scotia to Bar Harbour, Maine (Willison et al., 1997). This overview is generally focused within the Bay of Fundy boundary.

The Bay of Fundy encompasses offshore oceanic features with shallow banks and deep channels, and diverse coastal marine habitats. Hunter and Associates (1982) divided the Bay into two large regions, based on oceanographic parameters and biotic assemblages, with a transition zone between Point Lepreau and Musquash. They characterized the "Outer Bay" as more oceanic, with cold summer and warm winter temperatures, high current velocities, high salinity and high water quality. Numerous pelagic species are present such as tuna, sharks, herring, and groundfish. Pelagic birds, whales, and porpoises are common, and there is a high biodiversity of benthic invertebrates. The "Inner Bay" is described as having more extreme water temperatures, lower salinity, higher current velocities, and high levels of suspended matter. Pelagic species are not as numerous, and invertebrate diversity is greatly reduced.

OCEANOGRAPHY

The Bay of Fundy has an extreme tidal range. The length and shape of the Bay tends to accentuate the tides within the region, resulting in a tidal range which increases from 6 m at its entrance, to as much as 16 m at the head of the Bay. The combination of strong tidal currents (7-18 km/hr in some areas) and complex bottom topography results in tidal rips, whirlpools, upwelling, and intense mixing throughout the region. Open water conditions generally prevail year-round, except for Cumberland Basin, Shepody Bay, and small embayments scattered throughout the Bay, which may be occasionally covered by broken ice kept in motion by tidal range and currents.

Circulation patterns are described by McGuire (1977), and are shown for winter and summer surface circulation in Figures C.2 and C.3. There is a residual counter clockwise circulation as a result of incoming waters along the Nova Scotia shore of the Bay, as well as being influenced by the outflow of the Saint John river (Percy et al., 19[illegible]). Using drift bottle data, Bumpus et al., (1959) delineated the possible sources of water entering the Bay of Fundy through surface circulation. During January, this entry is restricted to the approaches of the Bay, but this expands during spring and summer to include waters from the Gulf of Maine and Georges Bank (Figures C.4 and C.5).

Surface temperatures at the mouth of the Bay of Fundy, where there is extensive stratification, range from 11°C in summer to 3-4°C in winter, and from 21°C in upper Minas Basin in the summer, to 0°C in the winter. Salinity near the mouth of the bay is

33‰, and falls to 28‰ in upper Minas Basin. (Greenberg, 1984). Bottom temperature and salinity distributions for summer and winter are seen in Figs. C.6 to C.9.

Page (2000, unpublished) summarized the oceanography of the Bay of Fundy as follows. "Because of the high tides and strong tidal currents, the Bay of Fundy is flushed rapidly and substances are diluted quickly. However, this is not always the case. Water circulation within the Bay of Fundy is dominated by the lunar tide. The tidal current flows into and out of the Bay every 12.42 hours at velocities of about 10cm s^{-1}. The mean or residual circulation is near to the surface water entering the Bay along the coast of Nova Scotia, and at depth through the deep entrance between Grand Manan and Nova Scotia. The New Brunswick side of the Bay is vertically stratified. It takes about 5-6 days for a water parcel to advect, or travel from near Saint John to past Grand Manan, a distance of about 50 km. The exchange ratio is the proportion of water that is removed during each unit of time, and the unit of time in Bay of Fundy is usually a tidal cycle. The inverse of this is the flushing or residence time, which is the time for 65% of the water in the box to be removed. Although flushing rates for individual sections were estimated to be only a few days, the flushing time for the Bay as a whole was estimated to be about 76 days, much longer than the time to advect out of the Bay in the surface layer".

Areas with unusually high benthic diversity almost always exhibit high productivity. Enhancement of Bay of Fundy waters is believed to occur as water passes from Saint John to the West Isles and Grand Manan, as a result of the presence of important nutrient and food pumps located in this area. Freshwater inflow into the Bay is substantial, and alters salinity levels at a local level. The Saint John River alone contributes 70% of the freshwater input into the Bay of Fundy (Hunter and Associates, 1982).

Productivity is exceptionally high, and is greatest at the mouth of the Bay. Overall productivity for Bay of Fundy was calculated by Prouse et al. (1984) to be 1124 x 10^3 tonnes per year. The Outer Bay, the area between Saint John, Digby, Brier Island, Grand Manan and Passamaquoddy Bay, represented 85% of that productivity (Figure C.10). Productivity in the Bay of Fundy ranges from 27 g Carbon m^{-2} in the Inner Bay, to 133 g Carbon m^{-2} in the Outer Bay. Hunter and Associates (1982) suggest that the marshes, estuaries (Figures C.10 and C.11), and intertidal and shallow subtidal areas (mudflat locations shown in Figure C.12), make significant contributions, and the Bay of Fundy seems to be more dependent on inshore production than on the phytoplankton production concept of offshore waters. A reasonable estimate of net above ground annual production for low salt marshes (those which are flooded twice daily) in Bay of Fundy, was calculated by Prouse et al. (1984) as 500 g Carbon dry wt m^{-2}. A large amount of this production is exported and distributed throughout the Bay. This massive area of salt marsh, 6,466 ha (Prouse et al., 1984), plays a major role in that ecosystem. The importance of the role of marshes is well recognized; Hicklin (2001, Appendix H) and Harvey et al. (1998) voice concern over the amount of salt marsh lost over the last hundred years, and suggest that they should all be protected.

TOPOGRAPHY AND GEOLOGY

The Bay of Fundy is a major structural embayment, the result of the opening of the Atlantic Ocean more than 160 million years ago, subsequently shaped by uplift, glaciation, and erosion. The Bay of Fundy is a 270 km long, generally funnel-shaped embayment, with an 80 km wide mouth and two narrow extensions at its head (Chignecto Bay and Minas Basin). Wildish et al (1998), estimated the total area of the Bay to be 11,149 km^2, with a total intertidal area of 1437 km^2 (Fader et al., *in* Wildish and Fader, 1998) describe the geology of the Bay as consisting of three major substrate types: Sambro Sand, at the head of the Bay; Scotian Shelf Drift, the original till material deposited at the last Ice Age; and LaHave Clay, in the deeper parts of the mouth of the Bay where tidal currents are the lowest. Surficial geological information is shown in Figure C.13. The Bay is less than 150 m in depth and generally less than 50 m deep. Its bottom topography is generally irregular, characterized by shoals, channels, reefs, islets, and islands, particularly at its mouth. Low-lying rocky shores predominate, interspersed with beaches and low eroding cliffs, though cliffs up to 200 m occur locally.

HABITAT TYPES

Geologist G. Fader (per. com. e-mail, 2001) prefers to use the European definition of habitat, which does not include the biological communities. That definition relates to pure geology: the physical component of the seabed where organisms live, feed, breed and die. Exceptions to the European definition are the rare cases, such as mussel beds or coral reefs, where the biological community creates the structure. The combination of the benthic community and the geology is the biotope. The seabed and its character of grain size, shape, porosity, thickness, sorting, or roughness, is the realm of the geologist; the geologist has the tools to map wide expanses of seabed in decimetres. The biologist on the other hand, must rely on video and samples that cover only a small area. It is the combination of biological and geological methods and data that provides the only way to effectively map benthic communities. A good example of this interdisciplinary approach is the work of Kostylev et al. (2001), whereby the analysis of sea floor photographs from Georges Bank was integrated with the interpretation of multibeam bathymetry. The World Wildlife Fund Seascape characteristics, developed by Roff and Day (2000), integrate surficial sediment information, along with other available physical data, to define seascapes that would include an expected assemblage of species.

Substrates can often be a predictor of species distribution (Kostylev, 2001), determining to a large extent, along with oceanographic factors, the distribution of various habitat types and the associated benthic species. Roff et al. (2003) suggests that a geophysical classification of habitat types may be used as a surrogate for marine community types. Owens (1977) divided the Bay of Fundy coastal environments into six categories, based on their geological and physical characteristics. The shoreline types are rock or cliff shorelines, shorelines with beaches, shorelines with intertidal sediments, and shorelines with vegetation. The updated shoreline classification data for Bay of Fundy (Eastern Charlotte Waterways, per. com., 2001) are shown in Section D of this report.

MacKay et al. (1979) related substrate type to the species assemblages counted *in situ* by divers. In that study, three substrate categories were used: rock, mixed, and mud/sand. Results found are shown here as part of the descriptions of various sites highlighted in Section D of this report. Results of a study of macro-epifauna in the lower Bay of Fundy by Caddy and Carter (1984), found further evidence of the relationship between common presence of species, and physical characteristics of the habitat.

Seven distinct intertidal habitat types are identified by Yeo and Risk (1981): salt marsh, beach, upper and lower mudflat, sand flat, channel lag and sand bar. Salt marshes and mud flats up to five kilometres in width are common at the head of the Bay, as shown in the distribution of major salt marshes in Figure C.11. Smaller marshes and mudflats can be located in the various detail maps in Section D.

Hunter and Associates (1982) divided the major habitat types even further into: rocky shores, muddy shores, sandy shores, mixed shores, tide pools, brackish ponds, estuaries, salt marshes, artificial habitats, and pelagic habitats. In their report they describe in detail these habitat types, along with locations and species lists. Prouse et al. (1984) estimated a total of 84,484 ha of mudflats and ledges in the whole of Bay of Fundy.

The shallow (40 m) rocky subtidal habitats are described by two biotic communities, defined by Logan and Noble (1971), Noble et al. (1976), and Webb (1976):

1) the crustose coralline algae community (*Lithothamniom* sp.), dominant in the photic zone, and;
2) the brachiopod *Terebratulina septentrionalis* community, a "distinctive" species exhibiting high fidelity to hard substrates (Thomas, 1983), occurring on the undersides of boulders and crevices, down to 20 m, then on upper surfaces at deeper waters. This deeper community exhibits the greatest diversity of benthic macrofauna.

Thomas (1983) also describes these communities and the associated species assemblages. MacKay et al. (1978 and 1979) use indicator species to compare different areas in Bay of Fundy, for assessment of their significance and representativeness. They found that on this basis they could identify not only species diversity (by their presence/absence), but also infer the diversity of habitat types.

In a report for the Gulf of Maine Council, Burt (1997) used information from experts to identify areas of anthropogenic importance. Species were selected as indicators of specific habitat types. For example, *Pandalus* would represent the same niche as calanoids; sand dollars represent low tide and shallow sublittoral habitat, urchins as hard substrate indicators. The species list originated from the Gulf of Maine Council list, modified to just the 30 top species, with those listed having been researched and therefore having information available. Tunicates, sponges, and cnidarians were not considered as important as others, and would be covered by the indicator species. Experts marked charts where species nest, feed, or are abundant, then the information was digitized, and layers superimposed. This information is presented here within the context of each site in Section D.

BIODIVERSITY

The Bay of Fundy area is critically important as a migratory staging area for millions of birds, and is also a significant summering and wintering area. At various times of the year important concentrations of gulls, terns, cormorants, phalaropes, Dovekies (*Alle alle*), Razorbills (*Alca torda*), Black Guillemots (*Cepphus grylle*), Common Murres (*Uria aalge*), and sea ducks occur throughout the region. Up to 34 species of shorebirds are found here in the autumn, with the largest concentrations (as many as 1.5 million birds) feeding on the mud flats at the head of the Bay. The region is particularly important to Semipalmated Sandpipers (*Calidris pusilla*), with 42-74% of the world population staging here in any given year.

The distribution of euphausiids and copepods throughout the Bay has a major effect on distribution of whales and seabirds. Iles (1979) identified the highest distributions north and east of Grand Manan. From June to October, important concentrations of harbour porpoise, finback, minke, humpback, and sei whales are found, notably in the outer Bay.

The mouth of the Bay is particularly important as a nursery area for the endangered right whale, mother-calf pairs and juveniles being the most commonly sighted. Harbour seals are resident and abundant.

The fish fauna is diverse, with over 100 species typically found in the Bay. The more common species include Atlantic cod, herring, various flounders, hake, pollock, redfish, mackerel, haddock, halibut, and assorted sculpins, skates and sharks. Diversity of finfish for the Scotian Shelf, Gulf of Maine, and Bay of Fundy were estimated by Strong and Hanke (1995) by using stratified random data from groundfish research surveys. They estimated relative diversity as the mean number of species captured per tow, and the frequency of capture was used as a measure of abundance. The Bay of Fundy was found to be the area with highest diversity of finfish, primarily in the fall. This diversity (Figure E.9) was evident in all the time periods analyzed (1970-93), with a high species inventory, and frequency of capture. The initial association of biodiversity with coastal Nova Scotia persisted, and additional areas developed in the center of the Bay of Fundy, southwest New Brunswick, and southwest of Grand Manan. Such centres of diversity were evident in other areas outside of the Bay of Fundy, but none of these persisted throughout the years analyzed, while several other areas demonstrated a consistently low diversity. Generally, areas showing high diversity shifted with season, from exclusively deep and mid-depth areas in the spring, to shallow, coastal, and mid-depth areas in the fall. While other factors may affect diversity (example: impact of bottom fishing gear or selective removal of certain species), geographic location seems to have a great influence on diversity, with proximity to coastal influences being a factor, such as rivers, marshes, islands and the associated fauna. The fact that diversity is highest in the fall results in part from the seasonal migrations of anadromous species to these rivers and estuaries (Strong and Hanke, 1995).

Several species of concern occur in the Bay of Fundy and Saint John River system (Litvak, 2001, Appendix H), including short-nosed sturgeon, the Atlantic sturgeon *Acipenser oxyrinchus oxyrhinchus*, and the Atlantic salmon. There are two distinct communities described by Dadswell (1996): 1) an estuarine group- small bodied and resident year round, represented by smelt, tomcod and sticklebacks; and 2) the large bodied migrants- many migrating long distances, although juveniles of some species are found year-round, represented by shad, sturgeon, cod, haddock, herring and sharks.

More than 800 species of benthic invertebrates have been reported in the marine region of the Bay of Fundy. Many references encountered described benthic epifauna as "macrofauna" (example: anemones, sea cucumbers, starfish; Logan et al, 1984), while others specified the term "megafauna" as organisms larger than 1 cm (e.g. scallops, soft corals, brachiopods) (Kostylev, 2001). Because of these variations in definitions, in this document, any reference to invertebrate macrofauna is synonymous with that of megafauna. MacKay (1974, 1977, 1978 and 1979) described distributions of intertidal and shallow subtidal macro-invertebrates for areas around the Bay of Fundy. These have been referenced in each site in section D.

EXISTING PROTECTED AREAS

There are several marine or coastal areas in the Bay of Fundy that are protected by Provincial, Federal, or International, agencies and agreements. Table C1 (D. Fenton, per. com., 2000) summarizes the various federal legislations associated with protection of habitat.

The Canadian Wildlife Services, part of Environment Canada, provides protection to areas designated as: National Wildlife Areas, which include coastal and marine areas such as Shepody Bay, Tantramar and Chignecto; Migratory Bird Sanctuaries, such as Machias Seal Island; and Marine Wildlife areas, of which there are none at present.

National Marine Conservation Areas are designated by Parks Canada to protect sites which are representative of Canada' marine regions. It is significant in itself that four of these conservation areas identified by Parks Canada are within the Bay of Fundy. The West Isles (Outer Quoddy Region), Grand Manan Archipelago, Brier Island, and Evangeline in Minas Basin, were identified as National Areas of Canadian Significance (NACS). The location of these NACS are shown in Figure E.10. At present there are no Bay of Fundy areas represented in the national marine conservation areas system.

RAMSAR sites are part of an international agreement to identify wetlands and coastal habitat of international importance. They do not provide legal protection, but utilize education and awareness to foster protection in areas such as Shepody Bay, Chignecto, Minas Basin, and Mary's Point.

In addition, there are several coastal areas managed by various conservation initiatives (Table C2), as summarized by the Atlantic Canada Conservation Data Centre (ARCAD) database (S. Garriets, pers. com., 2001). Figure C.14 shows the locations of these protected or managed coastal areas within 5 km of the Bay of Fundy shoreline.

Fisheries closures are also managed areas and are often contested as being "marine protected areas." However, these are not viewed as providing long-term protection to an area. Their intent is to assist in the management of a specific species during a critical time in its life cycle, such as spawning, and not to provide overall protection of the area on a permanent year round basis.

Table C1. Existing protected areas governed by various federal legislations

Agency	Legislative Tools	Designations	Mandate
Fisheries and Oceans Canada (Federal)	Oceans Act	Marine Protected Areas	To protect and conserve: • fisheries resources, including marine mammals and their habitats • endangered or threatened species and their habitats • unique habitats • areas of high biodiversity or biological productivity • areas for scientific and research purposes
	Fisheries Act	Fisheries Closures	Conservation mandate to manage and regulate fisheries, conserve and protect fish, protect fish habitat and prevent pollution of waters frequented by fish.
Environment Canada (Federal)	Canada Wildlife Act	National Wildlife Areas Marine Wildlife Areas	To protect and conserve marine areas that are nationally or internationally significant for all wildlife but focusing on migratory marine birds.
	Migratory Birds Convention Act	Migratory Bird Sanctuaries	To protect coastal and marine habitats that are heavily used by birds for breeding, feeding, migration and overwintering.
Parks Canada (Federal)	National Parks Act Proposed National Marine Conservation Areas Act	National Parks Proposed Marine Conservation Areas	To protect and conserve for all time marine conservation areas of Canadian significance that are representative of the five Natural Marine Regions identified on the Pacific coast of Canada, and to encourage public understanding, appreciation and enjoyment.

Table C2. ARCAD database of coastal areas managed by various conservation initiatives

ID	Name	Estab Date	Owner	Total Ha.
1	Herring Cove Provincial Park	1959	Govt of NB	424
2	Marshall's Cove DU	1987	Ducks Unlimited	24
3	Minister's Island Wildlife Management Area	1980	Govt of NB	202
4	Robert Stewart Nature Preserve	1990	NGO	24
5	Whale Beach Pond DU	1986	Ducks Unlimited	17
6	Mavillette Beach Provincial Park	1983	Govt of NS	77
7	Landsdowne Meadow DU	1989	Ducks Unlimited	9
8	Brier Island DU	1988	Ducks Unlimited	500
9	Brier Island	1988	NGO, Private	485
10	Central Grove Provincial Park	1976	Govt of NS	12

ID	Name	Estab Date	Owner	Total Ha.
11	Lake Midway Provincial Park	1981	Govt of NS	1
12	Peter's Island Sanctuary	1987	NGO	2
13	Smuggler's Cove Provincial Park	1982	Govt of NS	6
14	Brier Island	1987	Nature Conservancy of Canada	486
15	Savary Provincial Park	1974	Govt of NS	17
16	Machias Seal Island MBS	1944	Govt of Canada	18
17	Roosevelt Campobello International Park	1966	US-CA Joint Commission	1532
18	Chocolate Cove			24
19	St. Andrews Blockhouse National Historic Site		Govt of Canada	0
20	Grand Manan MBS	1931	Govt of Canada	250
21	Anderson Lake DU	1981	Ducks Unlimited	64
22	Bluemortier Brook 1 & 2 DU	1990	Ducks Unlimited	12
23	Castalia Provincial Park	1960	Govt of NB	8
24	Great Duck Island DU	1990	Ducks Unlimited	23
25	Irving Nature Park	1992	Corp	225
26	Oven Head Provincial Park Reserve		Govt of NB	32
27	St. George Marsh DU	1996	Ducks Unlimited	27
28	The Brothers Coastal Management Area	1992	Govt of NB	8
29	McMaster Island		Private	182
30	New River Beach Provincial Park	1959	Govt of NB	382
31	Lepreau Falls Provincial Park	1956	Govt of NB	12
32	Manawagonish Nature Preserve	1992	NGO	23
33	South Musquash DU	1985	Ducks Unlimited	77
34	Taylor's Island/Saints Rest		Corp	225
35	Musquash Estuary		Other	2500
36	Utopia Wildlife Refuge	1940	Govt of NB	3108
37	Musquash Marsh 1 & 2 & 3 DU	1984	Ducks Unlimited	180
38	Red Head Marsh DU	1984	Ducks Unlimited	60
39	Whale Cove Pond		Private	9
40	The Anchorage Provincial Park	1970	Govt of NB	175
41	Upper Clements Wildlife Game Sanctuary	1977	Govt of NS	254
42	Allain Creek DU	1981	Ducks Unlimited	15
43	Belleisle DU	1994	Ducks Unlimited	95
44	Belleisle Marsh	1991	Govt of NS	262
45	Boss's Pond DU	1978	Ducks Unlimited	4
46	Carleton Martello Tower National Historic Site	1982	Govt of Canada	2
47	Granville Ferry DU	1976	Ducks Unlimited	9
48	Jack Pine Meadows DU	1990	Ducks Unlimited	20
49	Mickey Hill Pocket Wilderness		Corp	12
50	North Hills Museum	1975	Govt of NS	6
51	Ryerson DU	1985	Ducks Unlimited	11
52	Upper Clements Wildlife Provincial	1973	Govt of NS	288

ID	Name	Estab Date	Owner	Total Ha.
	Park			
53	St. Croix Cove		Nature Conservancy of Canada	40
54	Upper Clements Provincial Park		Govt of NS	15
55	Port Royal National Historic Site	1940	Govt of Canada	3
56	Fort Anne National Historic Site	1940	Govt of Canada	7
57	Valleyview Provincial Park	1973	Govt of NS	41
58	Apple River DU	1980	Ducks Unlimited	100
59	Shepody National Wildlife Area - Germantown Marsh	1980	Govt of Canada	1128
60	Monument-Lefebvre National Historic Site		Govt of Canada	0
61	Cape Enrage		NGO	28
62	Saints Rest Marsh (beach)		NGO	9
63	Tantramar Wetlands Centre	1987	Ducks Unlimited	5
64	Newfoundland Creek DU	1982	Ducks Unlimited	79
65	Two Rivers	1992	Govt of NB	43
66	Two Rivers DU	1991	Ducks Unlimited	37
67	New Horton		Nature Conservancy of Canada	28
68	Two Rivers		Private	28
69	Amherst Point MBS/ Chignecto NWA		Ducks Unlimited	413
70	Missaquash 1-5 DU	1965	Ducks Unlimited	2605
71	Trans Canada Marsh DU	1987	Ducks Unlimited	20
72	The Brothers Islands	1995	NS Nature Trust	4
73	Blomidon Provincial Park	1974	Govt of NS	909
74	Boot Island National Wildlife Area	1979	Govt of Canada	144
75	Five Islands Provincial Park	1973	Govt of NS	519
76	Grand Pre National Historic Site	1961	Govt of Canada	13
77	Cottage Cove Provincial Park		Govt of NS	2
78	Minudie Salt Marsh DU	1975	Ducks Unlimited	167
79	River Hebert Marsh DU	1994	Ducks Unlimited	19
80	Rockland Marsh (1) DU	1985	Ducks Unlimited	29
81	Rockland Marsh (2) DU	1985	Ducks Unlimited	23
82	Sackville Marsh DU	1987	Ducks Unlimited	24
83	Seaman's Marsh DU	1989	Ducks Unlimited	15
84	Shepody Bay	1987	Govt of NB	12200
85	Taylor Village DU	1983	Ducks Unlimited	9
86	The Rocks Provincial Park	1958	Govt of NB	72
87	Dorchester Cape	1993	Nature Conservancy of Canada	36
88	Dorchester Cape		Private	36
89	Sackville Waterfowl Park	1987	Govt muni	11
90	Noel Lake DU	1981	Ducks Unlimited	168
91	Debert Wildlife Management Area	1973	Govt of NS	388
92	Minas Basin Wildlife Management Area	1977	Govt of NS	186
93	North Brook Marsh DU	1978	Ducks Unlimited	5
94	Parrsboro Fossil Cliffs	1990	Govt of NS	8

ID	Name	Estab Date	Owner	Total Ha.
95	Port Williams DU	1978	Ducks Unlimited	5
96	Prescott House	1971	Govt of NS	15
97	Sheffield Mills DU	1978	Ducks Unlimited	9
98	Southern Bight-Minas Basin	1987	Govt of Canada	26800
99	Spencers Island Sanctuary	1986	Corp	9
100	Starr's Point DU	1995	Ducks Unlimited	3
101	Walton River DU	1990	Ducks Unlimited	48
102	Spencers Island	1986	Nature Conservancy of Canada	8
103	Wolfville Ridge	1997	NS Nature Trust	47
104	Fundy Linear Park			2640
105	Hillsborough Marsh DU	1984	Ducks Unlimited	21
106	Dennis Beach Provincial Park Reserve		Govt of NB	9
107	Dover DU	1983	Ducks Unlimited	26
108	Mary's Point			1200
109	Akins Marsh DU	1987	Ducks Unlimited	60
110	Amherst Point # 1 DU	1971	Ducks Unlimited	10
111	Amherst Point # 2/3 DU	1973	Ducks Unlimited	338
112	Amherst Point # 3/4 DU	1995	Ducks Unlimited	93
113	Aulac Marsh DU	1972	Ducks Unlimited	344
114	Bacon's Pond DU	1994	Ducks Unlimited	2
115	Chignecto DU	1971	Ducks Unlimited	77
116	Chignecto National Wildlife Area	1980	Govt of Canada, Corp	1020
117	Chimac DU	1971	Ducks Unlimited	14
118	Eddy Road Cove 1 DU	1984	Ducks Unlimited	29
119	Eddy Road Cove 2 DU	1984	Ducks Unlimited	21
120	Etter Ridge DU	1984	Ducks Unlimited	7
121	Fenwick Provincial Park		Govt of NS	20
122	Fort Beausejour National Historic Site	1977	Govt of Canada	120
123	Fort Lawrence DU	1973	Ducks Unlimited	73
124	Lower Maccan DU	1985	Ducks Unlimited	11
125	Maccan #3 DU	1995	Ducks Unlimited	10
126	Maccan Point DU	1989	Ducks Unlimited	8
127	Maccan Rhode Island DU	1969	Ducks Unlimited	23
128	Maccan 2 DU	1969	Ducks Unlimited	7
129	McIver Marsh DU	1994	Ducks Unlimited	44
130	Atkinsons Marsh DU	1986	Ducks Unlimited	13
131	Baker's Marsh DU	1996	Ducks Unlimited	22
132	Calhoun Riverside	1994		156
133	Dorchester Cape		NGO	35
134	Dorchester Marsh (1) DU	1991	Ducks Unlimited	41
135	Dorchester Marsh (Mitton's)	1992	Govt of NB	41
136	John Lusby Salt Marsh DU	1995	Ducks Unlimited	664
137	Johnson Mills/Dorchester Cape	1994		36
138	Johnson's Mills	1988	NGO	37
139	Anthony Provincial Park	1974	Govt of NS	7

ID	Name	Estab Date	Owner	Total Ha.
140	Avon DU	1972	Ducks Unlimited	7
141	Canards Pond DU	1977	Ducks Unlimited	5
142	Cogmagum DU	1991	Ducks Unlimited	18
143	Davidson Meadow DU	1977	Ducks Unlimited	15
144	Dewey Creek DU	1977	Ducks Unlimited	9
145	Dewey Creek Wildlife Management Area	1982	Govt of NS	55
146	Fort Edward National Historic Site		Govt of Canada	12
147	Hillaton DU	1994	Ducks Unlimited	1
148	Hoffman's Marsh DU	1996	Ducks Unlimited	11
149	Joggins Fossil Cliffs	1972	Govt of NS	7
150	Lawrence House	1967	Govt of NS	1
151	Little Dyke DU	1985	Ducks Unlimited	13
152	Maitland Marsh 1 & 2 DU	1986	Ducks Unlimited	21
153	McEmons Pond DU	1987	Ducks Unlimited	42

D - DESCRIPTION BY AREA

1. GRAND MANAN AND AREA

The area of focus in this section is shown in Figure D.1.1. Cliffs on the west side of Grand Manan reach up to 60 m, and littoral sediments are scarce due to the resistant nature of the cliffs. Tidal ranges are 5-7 m, the residual currents run parallel to the coast and are particularly strong on the Grand Manan Channel, up to 2 m/s, (Pelletier, 1977). The area exhibits many of the characteristics of oceanic islands. In the shallow areas there are mixed substrates of sand and mud, which is as common as rocky substrate. The shoreline classification for Grand Manan is shown in Figure D.1.2.

The north end of Grand Manan, up to 5 km north of the northern end of the island, is an important wintering area for Razorbills, a species of regional concern. This is a shallow area, about 10 km^2 (44 48'N, 66 47'W) with much upwelling (Diamond, 2001, Appendix H). Other avian species using area in winter include Common Eider *(Somateria mollissima)*, Thick-billed Murre (*Uria lomvia)*, Common Murre, and Dovekie. Areas identified by Diamond (2001) as being important to seabirds are shown in Figure D.1.3. Large numbers of Common Eiders breed in this area (Hicklin and Smith, 1984). Castalia (Figure D.1.1 for location) has interesting coastal geomorphology, containing a large saltwater marsh with an abundance and diversity of common and rare bird species. Castalia is a bird sanctuary and a Provincial park (Hunter and Associates, 1982).

Finfish diversity determined from the 1990-1993 summer groundfish surveys (Strong and Hanke, 1995) shows the area Northeast of Grand Manan, as having more than 15 species per tow (Figure E.9). Chenoweth et al. (1989) reported a discrete fall spawning population of herring west of Grand Manan. Chenoweth et al. (1989) point out that the widespread spawning along the Maine coast and around Grand Manan is now confined to smaller areas in eastern Maine. Stephenson et al. (1999) (Figure E.5) show the locations of present and past herring spawning sites, one of which is located north of Grand Manan. Information from research surveys, from 1970-1981 shows spawning of witch *Pleuronectes americanus* and plaice *Hipoglossoides platessoides*, occurs on the eastern side of Grand Manan (Scott, 1983) (Figure E.2). A series of interviews with local fishermen identified southeastern Grand Manan as an active spawning area for cod and haddock (Graham et al., 2002). The Gravelly and the Bulkhead are known areas of lobster migration (Campbell, 1990) and groundfish spawning (Burt, 1997). Coon (1998) summarized the historical information available for spawning areas of lobster, herring, cod and pollock around Grand Manan (Figure E.4).

Lawton and Robichaud (2001) consider the eastern and southern shores of Grand Manan as sensitive from a lobster production perspective. A preliminary analysis of a trapping survey showed high catch rates of lobsters off eastern Grand Manan, and the widespread use by both juveniles and adults, of shallow water habitats during the summer. Areas in Long Island Bay, Seal Cove, Whale Cove, and Flagg Cove represent areas of high to medium abundance (Figure D.1.1 for locations).

Scallop spat settling areas, as related to the distribution of scallop and soft-shelled clam beds, are shown in Figure D.1.4. Periwinkle and urchin fishing areas are shown in Figure D.1.5. Surveys by MacKay et al. (1979) indicate that a high number of benthic invertebrate species are found in a mixed sand-mud substrate (43%), with a comparable, but lower percentage (37%) of rocky substrate assemblages. Moderate productivity was estimated for the benthic macro-invertebrates, as compared to other areas such as The Wolves and Head Harbour area (Section 2). Species diversity for these organisms as recorded by MacKay et al. (1979) is shown in Figure D.1.6. Whale Cove has one of the highest species diversity, and other areas with high ratings are North Head, Southeast Ross Island, and Northeast White Head Island (Figure D.1.1 for locations). This is corroborated by local knowledge suggesting that these subtidal areas are biodiverse (Bosien, 2001, Appendix H). Diversity data by Magee et al. (1999) obtained from scallop bycatch and limited to scallop dragging areas are shown in Figure D.1.7. Distribution of specific benthic fauna is available from both reports.

Results of gillnet by-catch studies by Trippel et al. (1996), suggest that harbour porpoise distribution in the Swallowtail area in the northern tip of Grand Manan, is high during summer months. He suggests that a substantial reduction in by-catch of harbour porpoise may be achieved by reducing gillnet effort in two small areas in Bay of Fundy, one of which is the Swallowtail area. (Figure D.1.8). Seal haulout areas were recorded from community and local knowledge (CCRM, 1991) and are shown in Figure D.1.9.

Locations of aquaculture sites and management areas, herring weirs, and rockweed and dulse harvesting areas, are shown in Figs. D.1.10 and D.1.11. A report by Neish (1973) to the New Brunswick Department of Fisheries and Environment described the broad distribution of dulse and other algal species around Grand Manan, and are shown in Figs. D.1.12-15. At a Significant Marine Areas Workshop (2001, Appendix H) several researchers suggested that both Castalia and Harrington Cove should be designated for increased protection on the seaward side. Presently there are focused studies on Castalia (sheltered site) and Harrington Cove (exposed site) as part of long-term biodiversity study for detecting changes in the Bay of Fundy, utilizing seaweeds as bio-indicators. This kind of research requires keeping reference sites with minimal anthropogenic impacts. Concerns and threats for such study areas (Figure D.1.11) are nutrification, siltation, and eutrophication (Bates et al. 2001, Appendix H). The sites used in this work are relatively small, but it is thought they should be part of a network of managed or protected areas, because the intent is to use them for long-term studies.

The Grand Manan area is rich in marine resources; consequently there is much overlap in utilization of the marine areas. In an analysis of important areas, Burt (1997) reports that the Grand Manan area scored heavily in terms of anthropogenic importance (aggregate habitat scores) due to haddock fishing grounds, herring, and the summer aggregations of whales, including the endangered right whale (Figure D.1.16). The Grand Manan archipelago has been identified as a Marine Natural Area of Canadian Significance (NACS), as shown in Figure E.10. Hardie (1979) and Messieh (1992) identified the Grand Manan archipelago as a critical marine habitat because of the right whale aggregations in August to November, and for the numerous species of seabird colonies during April to September that breed in the area. The Right Whale Conservation box is shown in Figure D.1.17.

Flagg Cove, Whale Cove

These areas are considered to fulfil the physiological requirements for lobster egg development and extrusion, because of the sheltered, shallow warm waters. A temperature of 11.2°C is the average for areas A, B, C during Aug.-Sept., 1982-83 (Figure D.1.18) (Campbell, 1990). The berried females found here do not stay long in the area, migrating offshore, north or east from Grand Manan into deeper waters, subsequently to the Grand Manan Basin, as shown in Figure D.1.17. Tagging studies showed that some lobsters returned to the same area (Campbell, 1986). Campbell suggests that these seasonal migrations to shallow warmer waters speed up development time of lobster larvae, thus increasing the probability of their survival. These large aggregations of berried females are found in the shallow waters off North Head, in Flagg Cove and Whale Cove (Campbell, 1990). Observations show that these lobsters escavate the sand-clay sediment into symmetrical bowl-shaped depressions (Campbell, 1990; Lawton, per. com.; M-I. Buzeta and R. Singh, per. obs.). In 1990, Campbell reported the results of a lobster trapping survey during August and September 1982-83. He found up to 90 berried females per 100 trap hauls in these shallow waters, 94% were larger than 94 mm (carapace length), the largest being 220 mm, and an average mean density of 2.3/100 m^2 was observed in area A of Flagg Cove (Figure D.1.18). Information collected in 1999 from local knowledge also identified these areas as lobster spawning areas; the Flagg Cove area identified corresponds with that by Campbell (1990). More recently during SCUBA surveys in 1989-91, Lawton and Robichaud (2001) have found that the high density of large berried females in area A has persisted. All results from these surveys suggest that Whale Cove and Flagg Cove function as lobster spawning areas.

Correlation analysis for ecological associations suggest crustaceans are very sensitive to chemical contamination (Chang, 1992), therefore, this area could be considered sensitive to various marine developments. In 1991, transect surveys by Lawton and Robichaud in Flagg Cove reported a dramatic and significant decrease in density in areas A and B, subsequent to the 1989 placement of an aquaculture site in area A. After the removal of the aquaculture site in 1991, the surveys showed an increase in abundance of berried female lobsters in area A, and by 1992 the numbers had significantly increased. Based on all the diving surveys done in southwest New Brunswick, and in Annapolis Basin, Lawton and Robichaud state that Flagg Cove remains a unique area for aggregation of berried lobsters during the summer.

While this area is within an aquaculture exclusion zone, this does not limit boundary expansions, the movement of an aquaculture site to a different location, or salmon production increases. There are concerns regarding potential environmental threats to these areas, which clearly demonstrate specific environmental qualities of value to this sensitive lobster life phase. Recently the occurrence of *Chorda* has been observed, a species considered to be a sign of eutrophication (Schramm and Nienhuis, 1996). These concerns have prompted interest in this area's long term protection, one option being that of a Marine Protected Area.

South West Grand Manan - Kent Island, Old Proprietor's Shoals, Murr Ledges

Kent Island is located 9 km south of Grand Manan (44°35'N, 66°46'W) (Figure D.1.1) (Wheelwright, 2001, Appendix H). It is part of the Grand Manan archipelago, which includes the nearby Head (or Hay) Island and Sheep Island. These islands are important nesting and feeding areas for eiders and other seabirds (Diamond, 2001; Blinn, 2001; Wheelwright, 2001; Christie, 2001; Appendix H). The Bowdoin Scientific Station, a research facility and a bird nesting sanctuary, was established on Kent Is. in 1935, and it recently received the designation as an Important Bird Area for Canada. In the 1930's, Kent Is. was one of last refuges of breeding Common Eiders in the Gulf of Maine, when the species was close to local extinction. Presently it is a major stopover for tens of thousands of migratory shorebirds (Wheelwright, 2001, Appendix H), and it contains one of largest colonies of Leach's Storm-Petrels (*Oceanodroma leucorhoa*). A total of 200 bird species, 60 marine algal species, and 280 plants species are listed for Kent Is. by the Bowdoin Scientific Station (www.academic.bowdoin.edu/kent_island). Wheelwright recommends that Kent Island should be designated an exclusion area for any aquaculture projects that threaten bird populations, long-term biological monitoring, or environmental education. Hunter and Associates (1982) also listed Kent Is. in their report on Proposed Ecological Reserves, while identifying the whole Grand Manan archipelago as an area of Regional Significance to seaducks, shorebirds, alcids, pelagic seabirds and phalaropes.

The Murr ledges area (Figure D.1.1) is identified as being important to seabirds, and the **Old Proprietor's Shoals**, southeast of Grand Manan, are considered to be a major wintering area for Razorbills. Most of the islands in this area, including Head, Kent, and Sheep are nesting and feeding areas for eiders and other seabirds, as shown in Figure D.1.3 (Diamond 2001, Blinn 2001, Appendix H). There are several reports in the literature on a small contribution to herring spawning in the Grand Manan area. Das (1968) found one instance of summer-fall herring larvae on the Murr Ledges in October 1963.

MacKay et al. (1979) showed an abundance of lobsters in dive transects SW of Grand Manan-Outer Wood Island, Three Islands, and White Head Island. Preliminary results of a lobster trapping survey (Lawton, per. com.) show high relative abundance of lobsters in Seal Cove and Long Pond Bay. Generally, the results demonstrate the wide use of these shallow water habitats during the summer. Strong and Hanke (1995) identified the area south of Grand Manan as the highest finfish diversity in the springtime (Figure E.9).

Machias Seal Island

Located about 19 km SW of Grand Manan (44 30'N, 67 06'W), Machias Seal Island is a flat, craggy, rocky, and treeless island, approximately 16 ha (Figure D.1.1). The island has a lighthouse station and is a research site. It is considered the most important nesting area of seabirds in the Bay of Fundy. It was declared a Federal Migratory Bird Sanctuary in 1944 (Diamond 2001, Davidson 2001, Appendix H). In 1975, it was recommended as an Ecological Reserve by Wein and Jones, for its value as a bird nesting area, particularly for the Arctic Tern (*Sterna paradisaea*) and the Atlantic Puffin (*Fratercula arctica*). The island is visited frequently, but visitors adhere to strict guidelines. The Marine Conservation Biology Institute (1999, MCBI website) identified it as one of the areas of "highest priority" for protection (Figure E.17).

The area has also been proposed as a reserve (Figure E. 15), as a National Area of Canadian Significance (Figure E.10), and has been identified for its significance to alcids, pelagic seabirds, shorebirds, terns and waterfowl (Figures E.11-14), and rated highly as an important area in Burt's 1997 report (Figure D.1.16). Considerable numbers of breeding Atlantic Puffins, Razorbills, Arctic Terns, and Common Terns (*Sterna hirundo*), are found in this area (Hicklin and Smith, 1984) (Figure E.13). Roseate Terns (*Sterna dougallii*), a nationally endangered species, regularly occurs although nesting has not been confirmed (IBA website, 2001). Birds listed also include Leach's Storm-Petrel, Spotted Sandpiper (*Actitis macularia*), Razorbills, and Black Duck (*Anas rubripes*) (Wein and Jones 1975, Brylinsky et al. 1996). The Razorbill and Arctic Tern are species of regional concern. Diamond (2001, Appendix H) proposed a minimum zone of 5 km around the Island which he considered essential for food gathering by birds (Diamond, 2001, Appendix H).

Grand Manan Basin (Right Whale Conservation Box)

This area contributes 90% of the total primary production of the Bay of Fundy (Prouse et al., 1984), and represents one of two tidal pumps which support biological production in the Bay of Fundy (Percy et al., 1996). Primary production in this area is extremely high due to major upwelling and mixing. Distribution studies of euphausiids (Isles, 1984) showed the highest concentrations are in the Grand Manan Basin-Brier Island area. Large concentrations of the euphausiid *Meganyctiphanes norvegica* are estimated at <41,000/m^3 in this area, providing food for whales, fish and seabirds (Percy et al., 1996). Euphausiids and copepods sampled in October and November 1969 were most abundant (>20/m^2) in this area (Iles, 1975). Copepods showed a more regular distribution in the Bay of Fundy, but high diversity and concentrations were also found in this area. This productive area is a critical summering area for Arctic seabirds. Wilson's Storm-Petrel (*Oceanites oceanicus*), and greater and lesser seabirds are abundant at various times in the summer (Diamond, 2001, Appendix H).

As a result of this high productivity, several cetacean species, including the endangered right whale *Eubalaena gracialis*, large pelagics such as basking sharks, and seabirds, are attracted to this area. Areas of concentration for sharks are the same as those where the right whales are found in the summer. Turnbull (2001, Appendix H) points out that the basking shark is receiving protected status in various parts of the world; it has recently been listed as a candidate species for protection by COSEWIC.

The important areas for marine mammals are many, as L. Murrison (per.com. 2000) points out, and most are associated with strong upwellings such as the Whistle Rip off the northern end of Grand Manan, the Bulkhead Rip and Clarks Ground - southeast of White Head, and an area south of Gannet Rock. In between these areas are "travelling" corridors that may also include some feeding areas depending on herring aggregations. The area used by right whales is much larger than the conservation box, and covers much of the lower Bay.

The **Right Whale Conservation** box (Figure D.1.17), designated by the Department of Fisheries and Oceans, is located in the Grand Manan Basin, between Grand Manan and Nova Scotia. This area is an important feeding and calving area and a high percentage of juveniles are seen in the area. It represents one of only two summer aggregation areas for right whales (Brylinsky et al., 1997). The whales typically remain in the area between July and October, but can arrive as early as June, and remain up to December (L. Murrison, per. com. 2001). One of the recommendations in the Right Whale Recovery Plan (National Fisheries Service, 1991) is the establishment of a Marine Protected Area, although this is not viewed as the only solution. The report outlines potential threats to the North Atlantic right whales while in the vicinity of Grand Manan. A bottom gillnet fishery is located inshore of the Grand Manan Basin, and this is thought to be a potential threat if the whales moved north as they did in 1972. Fish weirs do not normally cause harm, but entrapment of these whales has occurred on several locations. Longlining and otter trawling occurs, but are not viewed as threats to North Atlantic right whales. Inshore lobster pots do not appear to threaten North Atlantic right whales significantly, even though there is a seasonal overlap. However, an offshore lobster fishery, which began in 1988, entangled and drowned one North Atlantic right whale in November 1988.

2. QUODDY REGION

The Quoddy Region (Figure D.2.1) is located in the southwest New Brunswick coast, in the lower Bay of Fundy, and adjacent to the coast of Maine, USA. It is often described as two subregions: Inner and Outer Quoddy. Chevrier (1959) delineated the line between the two so that Passamaquoddy Bay and the St. Croix Estuary are part of the Inner Quoddy Region. The Outer Quoddy region is bounded by the Passages (Passages section, below), and by a line running from West Quoddy Head to Grand Manan, and to Point Lepreau, giving the Outer Quoddy Region an area of 544 sq. km. Smith et al. (1984) delineated their study area to include Deer Island, the 40 plus small islands, numerous ledges, the Deer Island passages (Letite and Western), and Head Harbour Passage. The largest (25-30 sq. km.) of the islands, Deer Island and Campobello, are populated; the smaller islands range from 0.26-3.88 sq. km. For about 100 years, this area has received attention from several developments. The Quoddy Region supports various commercial and non-commercial fisheries, including the herring weir fishery, and most recently, the rockweed and salmon aquaculture industries. The Quoddy area has become the focal point for salmonid aquaculture in Atlantic Canada.

Loucks et al. (1974) describes the surface circulation pattern (from Chevrier, 1959) for the areas around Southwest New Brunswick and Grand Manan (Figure D.2.2), and the tidal excursions in the Quoddy region. He estimates that in the event of a disaster such as an oil spill, horizontal dispersion would cause the contamination of much of the Quoddy area within a week. The tidal velocities in the southwestern New Brunswick area vary considerably on short spatial scales, and magnitudes range from near 0 $cm \cdot s^{-1}$ to several

100 cm·s^{-1} (Page, 2001, unpublished). Page notes that the updating of Forgeron's tidal excursion data (*In* Bumpus et al., 1959), would greatly assist in management of these islands, and the potential grouping of some of these together as management areas. Scientists suggest that the Quoddy area is ecologically unique as a result of the large tidal amplitudes, combined with the region's benthic topography, and the effect that the many islands have on the tidal streams around them.

The proposed National Marine Park (Figure E.10), the proposed tidal hydroelectric power (Gordon and Dadswell, 1984), and the proposed oil refinery at Eastport Maine (Scarratt, 1979), have resulted in several intensive studies of this region. Studies at that time showed that this area had the highest degree of environmental risk of any site on the Eastern Canadian coast (Yuen, 1976). This fact, and the proximity of several academic and research institutions, has no doubt given this area more visibility than other areas in the Bay of Fundy. Regardless, this region, specifically Outer Quoddy (West Isles), has numerous references to its ecological significance. Messieh (1992) identified the Quoddy region as a critical marine habitat for herring (1-2 year olds), and the outer areas for feeding of Red-necked Phalaropes (*Phalaropus lobatus*) in late July to early September. The International Marine Mammal Association (IMMA, 2001) proposed the Quoddy Region as a Marine Protected Area (Figure E.16) because of its importance to marine mammals as a feeding area. Their premise is that the area shares many of the features that define Canada's vision of a Marine Protected Area, and the IMMA considers it an excellent candidate for designation. Reasons listed are the presence of the endangered North Atlantic right whale, a transient resident of the Quoddy Region, the harbour porpoise, currently listed as threatened in this region, and several other species of whales all found in this region during late summer and early fall. The Quoddy Region also contains some of the most unique habitats in eastern Canada, forming a vibrant marine ecosystem second to none in Canada, and one of Canada's most productive coastal areas. Brilliant (2001, Appendix H) points out that often southwestern New Brunswick is overshadowed by the upper Bay which is dominated by mud flats, salt marshes and large bird migration areas, and that it is often seen as an aquaculture and fishing centre. However, this area contains a lot more of the hard substrate than exists generally in the Bay of Fundy, and has significant aspects that need to be protected.

One of the areas most often reported in the scientific literature as being ecologically sensitive[1], is the Quoddy Region. In an environmental risk assessment for this area as an oil terminal, it was quoted as having the "highest degree of environmental vulnerability, and hence, the highest environmental risk of any site on the Canadian eastern seaboard" (Yuen, 1976).

Inner Quoddy-Passamaquoddy Bay and St. Croix

Passamaquoddy Bay (Figure D.2.3) is approximately 100 km^2, with a mean tidal range of 6 m. There is a counter-clockwise surface water circulation pattern, shown previously in Figure D.2.2 from Chevrier, (1959). Estimates of flushing time for Passamaquoddy Bay is 15-16 days (Ketchum and Keen, 1983; Page, 2000, unpublished). Although existing flushing estimates are crude, they do suggest that the Bay, and some of the inshore coves and inlets, may not be flushed as quickly as perhaps imagined by some. The length of the St. Croix Estuary is approximately 36 nautical miles, and it is estimated that it contributes 50% to the inflow into Passamaquoddy Bay. The average depth is 12.2 m, with a max of 39.6 m used as the navigational channel (MacKay et al., 1978). Flushing time estimate is 8 days (Ketchum and Keen, 1983). The shoreline surrounding Passamaquoddy Bay and the St. Croix Estuary is quite diverse, but is mostly of mixed sand-gravel beaches, bedrock, and tidal mud flats (Figure D.2.4). The enclosed nature of Passamaquoddy Bay has promoted siltation, and mud is the predominate substrate (MacKay et al., 1978). The substrate type in the area provides suitable habitats for scallops and soft-shelled clams (Figure D.2.5). The substrate type was mapped by MacKay et al. (1978), and more recently with the use of sidescan and multibeam sonar by J. Hughes-Clark (per. com., 2002).

In 1982, **The St. Croix Estuary** (Figure D.2.3 for location) was proposed as an Ecological Reserve for its significant land features, and its regional significance as a feeding and staging area for ducks, geese, shorebirds and gulls (Hunter and Associates, 1982). Also in 1982, the State of Maine identified the St. Croix River as a Class A river for its natural, recreational, and historical significance. This provided a degree of protection through the Maine Rivers Act. It was also designated a Canadian Heritage River in 1991, currently the only one in New Brunswick. The St. Croix Estuary Project (1997), concerned with the proper management of this area, reported on its importance to the economy of the area, which includes clam and scallop beds, rockweed harvesting areas, and lobster areas, as well as many marine activities. The report details concerns and management plan actions, as well as profiles the system by identifying the physical, biological and socio-economic aspects. Near the point that separates the estuarine waters from those that are part of the St. Croix River, is Todds's Point (Figure D.2.3 for location). A parcel of land approximately 1.3 km^2 (170 acres land, 160 of it being intertidal), Todd's Point is protected by the St. Croix Estuary Project and the NB Nature Trust, as the Whidden and Eleanor Ganong Nature Park. The nearby community considers this area a special place because of its diverse tide pools, intertidal area, and historical context.

About 4.59 acres in size, **Sam Orr's Pond** (Figure D.2.3 for location) has been used as a study site by many scientists and students. Because of its atypical warmer waters, there have been several trials at introducing the oyster *Ostrea edulis* to the pond (Mortimer, 1960; Downer, 1959). There is a cyclical fluctuation of surface salinities, ranging from 30 ‰ - 4‰ and while there is regular flushing into the pond, there are several days each month during which no tides enter the pond. Temperatures in the summer are consistently above 20°C, with a minimum recorded at 8.8°C (Mortimer and Downer, 1961). The interest in preserving this area stems from the flora and fauna that are atypical to this area. The quahaug *Mercenaria mercenaria*, typical of warm water areas, is native to the pond (Reid et al., 1962). Its presence in this area goes back 10,000 years and is of historical and traditional importance, as the quahaug was a food source for the Abenaki tribes. Other species found are *Fundulus heteroclitus*, the tomcod *Microgadus*, sticklebacks, and *Corophium insidiosum*. Large numbers of elvers *Anguilla rostrata* are always present (Mortimer and Downer, 1961). The pond is now part of the Caughey-

Taylor Nature Preserve established by the New Brunswick Nature Trust in 1999. The reserve encompasses approximately 250 acres of land, salt marsh, and tidal estuary.

There are several small islands in the north of Passamaquoddy Bay that are considered to be very important areas for sea ducks, gulls, sandpipers and phalaropes (Christie, 2001, Appendix H). The areas around St. Andrews, Chamcook, Digdeguash and the Magaguadavic River were identified as Regionally Significant by Hunter and Associates (1982) because they serve as feeding and staging areas for ducks, shorebirds, eagles and Osprey (*Pandion haliaetus*). Locations of islands discussed are shown in Figure D.2.3. Approximately 35 acres, Hardwood Island was identified as a breeding site for herons, gulls and Common Eiders (Thomas, 1983). In 1975, it was recommended as an Ecological Reserve (Reserve #20) by Wein and Jones (1975), for its diverse avian population, and for the purpose of preserving this natural area for science, education, for gene pool preservation, and to provide a benchmark. At that time, it was considered to have a large and diverse avian population, with a large nesting colony of Great Blue Herons (*Ardea herodias*), nesting Ospreys, and thousands of Herring Gulls (*Larus argentatus*), and was an important stopover for migratory birds. The island is also home to a large and important Common Eider nesting colony (Diamond 2001, Appendix H). Another small island, Dick's Island, is interesting for its cultural, historical and archaeological aspects, while Hog Island has eider and cormorant colonies, and is likely to be acquired by the Nature Trust (Diamond, 2001, Appendix H). An aquaculture site right next to Hog Island is thought to cause a disturbance to these colonies.

Northern Passamaquoddy Bay (Birch Cove, Bocabec Cove, Dicks Island and Hog Island) has a higher relative abundance of lobsters than the eastern and western areas of the Bay (Figure D.2.6). During transect studies designed to identify inshore lobster distributions, Lawton (1993) found that the area from McCann Head to Creighton Point, next to Dick's Island, had a lobster population characteristic of a lobster nursery area. Birch Cove specifically was found to have a significant juvenile lobster population occupying the shallow subtidal boulder/cobble habitats. Hardwood and Hospital Islands have an extensive shelving ledge on the southern and eastern flanks, with few lobsters.

Distribution and abundance of intertidal and benthic biota was studied by MacKay et al. (1978). Principle biotic groups were found to be molluscs, echinoderms and marine plants. Sponges and tunicates were poorly represented, most probably due to temperature and salinity fluctuations in the area, although water quality may also be a factor. Rated occurrences of the major taxa were reported in MacKay et al. (1978), and the summarized diversity distribution (number of species) is replicated in Figure D.2.7. The five key areas of productivity, as indicated by the diversity/abundance rating, are shown in Northern Passamaquoddy Bay, two around St. Andrews, and the St. Croix Estuary. The St. Croix Estuary is a true estuary, and has the mixed faunal assemblages typical of both high and low salinities.

Harvesting of sea cucumbers occurs along St. Croix Island and off St. Andrews (Figure D.2.8) (M. Lundy, per. com., 2000). There is a high abundance of rockweed in the St. Croix Estuary and Passamaquoddy Bay, and this has resulted in a rockweed harvesting industry. The designated study areas around St. Andrews and Pagans Cove in the St. Croix are shown in Figure D.2.8 (B. Semple, per. com.). The area has several known seal haulouts in the southern part near Pendleton and MacMaster Islands and the area is recorded to be frequented by dolphins.

In 1934 McKenzie reported locations of cod spawning, and included an area sampled in northern Passamaquoddy Bay (Figure E.1). However, in a report on fishermen's knowledge of spawning areas, Graham et al. (2002) found no evidence that this area persisted. Passamaquoddy Bay has historically been used for the herring weir fishery, although many weir locations identified in 1999 (Figure D.2.9) are no longer active. More recently, the aquaculture industry has expanded into this inshore area. The New Brunswick Government has zoned the entire Passamaquoddy Bay as a "controlled growth area" for aquaculture development (Figure D.2.9). Concerns regarding aquaculture relate to the effects on water quality, the reduction in dissolved oxygen, and the potential for eutrophication. Relatively high values of ammonia are found in this area, as opposed to the typical concentrations found in this type of environment (Percy et al., 1996).

Outer Quoddy - The West Isles, the Passages, the Wolves Islands and Letang Estuary

The West Isles area has importance to First Nations Peoples, as Passamaquoddy Chief Hugh Akagi (2001, Appendix H) recalls stories of his great uncle, Wallace Nicholas, hunting porpoise and fishing along these islands, cleaning his catch on the very beaches he would like to see protected.

For thousands of years people enjoyed these islands bordering Passamaquoddy Bay for many reasons, hunting, fishing, gathering, as well as feasting and for religious ceremonies. Prior to European settlement, the West Isles or "Quoddy" area was frequented by the Passamaquoddy tribe and there are several shell midden sites as evidence, as well as recollections of porpoise hunting from canoes. More recently in the summer of 2001, members of the Passamaquoddy-Scoodic tribe reflected on the spiritual importance of this area.

"One of the most beautiful of these islands is now known as McMaster Island, and one of the most tranquil settings is what has become known as Ships Cove. The importance of preserving these links to our past has not been lost……… How can we tell (our children) *how their ancestors walked among these islands enjoying their existence in such a beautiful world surrounded by open waters, peaceful bays, crying eagles; when they must look at cage sites ……….As we struggle to recover our past it is becoming ever so vital that places such as Ships Cove and McMaster Island be spared ……. We need tranquil areas to appreciate and experience what is around us, we need not lose what we already have"* (Chief Akagi, 2001, Appendix H).

This area is often interchangeably called West Isles, Fundy Isles (usually includes Grand Manan), Outer Quoddy Region or Quoddy Isles (Figures D.2.1 and D.2.10). The geology of this area is such that there are steep zones and submerged rock debris, boulders and ledges; shoreline classification is shown in Figure D.2.11. Several of these ledges are known seal haulouts (Figures D.2.12 and D.2.13, CCRM, 1999; Terhune, 2001, unpublished; Parks Canada/Tourism NB, 1985). The uniqueness of this area is thought to result from the combination of large tides, complex benthic topography, and the tidal streams around these scattered small islands. The island mass effect results in asymmetrical tidal streams, eddies and gyres. This causes many shear zones, upwellings, and convergences, that force plankton to the surface in concentrated patches. Upwelling areas and other oceanographic features are shown in Figure D.2.14. It is these plankton concentrations that attract fish and seabirds (Smith et al., 1984).

Gaskin et al. (1985) noted that this region is considered "*ecologically unique, noted for its complex oceanographic and biological events.*" Their study area encompassed the waters that flow mainly through two passages, Letite and Western Passages, which includes the West Isles District, Deer Island, Campobello, and the forty plus islands and ledges. This area is considered one of the principal areas for enhancement of Fundy waters as they pass from Saint John to the West Isles, an area where zooplankton depletion or enrichment occurs (Hunter and Associates, 1982). There is an inward water flow along the Deer Island side of the Passage, and an outwards flow along the Campobello side (Figure D.2.2). Areas with unusually high benthic diversity almost always exhibit high productivity. In the Head Harbour Passage area the upwelled plankton are the euphausiid *Thyanoessa,* and the copepod *Calanus finmarchicus*. This attracts large flocks of Bonaparte's Gulls (*Larus philadelphia*), Red-necked Phalaropes, and herring to the area in late July to September. The West Isles and Passages area is documented as an important avifauna area (Figure D.2.15) (Parks Canada/Tourism NB, 1985; Diamond 2001, Appendix H).

The outer Quoddy area, including The Wolves and the numerous small islands, are an important staging area for seaducks, and support 2,500 pairs of breeding Common Eiders (Brylinsky et al., 1996; Hicklin and Smith, 1984). Red-necked Phalaropes prey on *Calanus finmarchicus*, and therefore move according to the tides in the Quoddy region. This area is not only considered an important staging area for phalaropes, but also it may possibly host the entire breeding population of eastern Canada, Greenland and Iceland (Duncan, 1996). The decline in copepod abundance in this area since 1990 has resulted in the decline of phalaropes, which may have been diverted to alternate staging areas.

The food chain outlined by Smith et al. (1984), includes copepod and euphausiid aggregations, mackerel, herring, squid, Common and Arctic Terns, gulls and Bonaparte's Gulls, Northern (Red-necked) Phalaropes, finback, humpback, and minke whales, and harbour porpoise (Gaskin, 1977). These aggregations are visible, but highly mobile according to tidal cycles, especially in the areas between the West Isles, Head Harbour Passage, White Horse Island and The Wolves (Gaskin and Smith, 1978). Unconfirmed records of right whale sightings, and several published and current records of humpback, finback, and harbour porpoise mother and calf sightings are shown in Figure D.2.16, as well as previously in Figure D.2.13. Gaskin specifically mentions that the shelf off White Island, and the sill close to the tip of Campobello Island, seem to be critical features in the feeding areas for finback whales, as shown in the tracks recorded by Gaskin and Smith, (1979) (Figure D.2.13). The core areas important for harbour porpoise, finback whales and for marine birds, are Letite Passage and Head Harbour Passage, west to Spectacle Island and Sandy Island, and out to White Horse Island (MacKay et al., 1978). In the Gulf of Maine report on habitat identification of critical species in the Quoddy region, Burt (1997) indicated that high abundances of harbour porpoise (*Phocoena phocoena*) occur in the area north of Head Harbour, while medium abundances occur east of Campobello Island (Figure D.2.17). A study of porpoise by-catch by Trippel et al. (1996), showed that the largest number of porpoise caught in gillnets in the Bay of Fundy occurs in the Quoddy area, from the West Isles, to North Head, Grand Manan (Figure D.2.17).

The harvesting areas for periwinkle, kelp, dulse, and the harvesting areas for the sea cucumber *Cucumaria*, are shown in Figure D.2.18. Distribution of common algae was recorded by Neish (1973), and is shown in Figs. D.2.41-44. Chlorophycophyta species such as *Ulva* and *Enteromorpha*, and the laminarian *Chorda filum*, are associated with nutrification, and these species are now being seen in areas not recorded previously by Neish (M. Owen, per. com., 2001). Rockweed occurs in high abundance, and has also resulted in harvesting activities in the area. A rockweed study area (some 139 hectares) has been set aside around Pendleton Island, Simpson and Mowat Islands in the north end of Deer Island (Figure D.2.19). The area also has several soft-shelled clam and scallop beds. Relative abundances of lobsters found during diving transects in selected areas are indicated in Figure D.2.20 (Lawton, 1993).

Scott (1983) reported several species of flounder spawning in May (Figure E.3), in the area between Campobello and The Wolves.

Owen (2001, Appendix H) summarized concerns for the Passamaquoddy Bay/Quoddy Isles area. As a marine biological educator with 29 years experience of teaching, diving and sampling in the area, Dr. Owen would like the ecological concerns for this area addressed, possibly as a Marine Protected Area, while there are still relatively undisturbed sites left. As a result of benthic transect work, and considerable experience in diving in this area, Lawton (1992, 1993) suggests that many of the communities found in this area may be of conservation significance and should be further evaluated. While not intended for evaluation of these communities, his surveys demonstrated that these highly diverse benthic communities do not appear to be generally distributed throughout the region. The Deer Island Archipelago and passages area, was identified as regionally significant, and was proposed as an Ecological Reserve by Hunter and Associates (1982), for its high quality scenic views, excellent representation of marine shore environments, and a very high diversity and abundance of marine invertebrates, fish, birds and mammals. In a Gulf on Maine report, Burt (1997) reported the presence of regionally significant species, such as redfish, juvenile cod, pollock and whales, which impart a high importance rating to this area. In 1975, Parks Canada (1985) identified the West Isles as one of four marine areas in the Bay of Fundy considered as a Natural Area of Canadian Significance (Figure E.10). A study to assess the feasibility of creating a national marine conservation area in the West Isles found that though technically feasible, the prospect of a marine park, with a large influx of visitors, was not supported by local residents. In 1999 the Marine Conservation Biology Institute, a scientific and conservation organization, convened 21 Canadian and USA scientists in order to identify "highest priority areas for protection" (Figure E.17). The West Isles was one of the areas identified in the Bay of Fundy, because of its high diversity of benthic fauna. Hunter and Associates (1982) proposed the Green's Point area as an Ecological Reserve. This peninsula has a lighthouse, a community managed Coastal and Marine Interpretive Museum and Aquarium, and a salmon aquaculture site. It is traditionally used for sightseeing, and university and school studies, and is the site of a long-term biodiversity study, monitoring changes in the Bay of Fundy by using seaweeds as bioindicators (Chopin et al., 2001, Appendix H). At this site there have been several sightings of finback, humpback and harbour porpoise, and a right whale sighting. Several of these coastal and island sites are used for intertidal and subtidal studies, monitoring and recreational diving. Mohawk Island is a long-term rockweed study site (Bosien, 2001, Appendix H); Simpson's Island is used for university intertidal ecology instruction; Mowatt, Adams, Simpson's, Bean's Island Ledges, Haddock Ledge, Casco, Sandy and Spruce Islands are used for subtidal graduate studies, monitoring and recreational dive charters (Figure D.2.10 for locations). Concerns for study and monitoring sites include siltation, eutrophication, and harmful alteration of coastal waters (Bates et al., 2001, Appendix H; Bosien, 2001, Appendix H; Owen, 2001, Appendix H). Management recommendations for small monitoring sites such as those used in algal studies, included placing a network of coastal management areas, marine protected areas, or Biosphere sites.

As with the Passamaquoddy Bay, there has been a historical herring fishery in the West Isles area (Figure D.2.21). Aquaculture sites in the Western Isles are restricted to their present numbers, as this is a restricted aquaculture growth zone. However this does not preclude the movement of sites to other locations, or the expansion of the present site boundaries, or production increases. There is concern that the increased particulate matter, which forms a "sludge," and the increased levels of ammonia and nitrates, will potentially cause eutrophication (Percy et al., 1996). Significant changes in the benthic community near aquaculture sites have been recorded by Lim (1991), and Hardgrave et al. (1993). Many of the West Isles sites described for their uniqueness are not yet developed and in reasonable "health," and their ecological integrity could still be maintained. Brillant (2001, Appendix H) suggests that un-impacted areas in the southern Bay of Fundy should be considered for protection. Brillant (2001, Appendix H) draws the contrast between some relatively un-impacted areas with those of intensive aquaculture, such as Letang Inlet.

The Passages – The Western Passage supplies 61% of the water entering Passamaquoddy Bay, Letite Passage 34%, and 5% passes through Little Letite Passage (Forgeron, *in* Bumpus et al., 1959). These are high velocity channels, caused by the frictional resistance of the tidal water movements against the complex benthic topography. This intense vertical mixing brings plankton to the surface, making these areas particularly attractive to faunal aggregations (Smith et al., 1984).

Letite and Little Letite Passages (Figure D.2.10 for location) are narrow channels north of Deer Island. In these areas, Black Guillemots, Common Eiders, Red-breasted Mergansers (*Mergus serrator*), and scoters are common (Thomas, 1983). Bald Eagles (*Haliaeetus* *leucocephalus*) are also common in the area. Western Passage and Letite Passage are used during the fall migration of Bonaparte's Gulls and Arctic and Common Terns (Diamond, 2001, Appendix H). Hunter and Associates (1982) reported that the waters and islands of Head Harbour Passage are of major Canadian significance because of high concentrations of migrating, feeding and breeding birds (phalaropes, ducks shorebirds).

Little Letite Passage and other passages are considered important to larval settlement and food supply for filter feeders (Thomas, 2001, Appendix H). Diversity is extremely high and there is a fantastic population density of filter feeding organisms; with some sponge species yet to be described. Thomas (2001, Appendix H) considers all the passages worthy of protection, and while Little Letite might be more manageable because of size and lack of development, all the passages display the finest biodiversity for benthic organisms in the Bay of Fundy. He describes Pendleton Passage as approximately 300 m wide, 500 m long, and 0-25 m deep, with very fast tidal currents of >100 $cm{\cdot}sec^{-1}$ at the bottom, and a unique assemblage of organisms adapted to feeding in these extreme current conditions. It has a very high percent cover of benthic organisms, including one new species of sponge described that so far has not been found anywhere else. Thomas (2001, Appendix H) recommends that the passage should be a marine sanctuary with no fishing of any kind, no moorings, and no shoreline development. In the absence of wider protection, Little Letite Passage would be a logical choice for special protection as it is well studied, carries minimal boat traffic, has no present development and has good access for research and education. The shorelines along the passages are mostly of bedrock (Figure D.2.11 for shoreline classification), and in his report on lobster habitat, Lawton (1992, 1993) states that, while areas in the Deer Island Passages may not have great significance from a lobster habitat perspective, the presence of vertical rock walls and high currents results in a highly diverse and abundant community of sessile organisms. Thus, their significance for marine conservation should be further assessed as these provide habitat for a high diversity of benthic species.

While these areas have not previously been utilized, there is a recent concern that they are now being threatened by development and inshore dragging (Bosien, 2001, Appendix H). Preliminary analysis by M. Lundy (per. com., 2002) of the 2000 sea cucumber fishery data, confirms dragging effort is along the Letite Passage from MacMaster Island to Parker Island (Figure D.2.18). On the east side of MacMaster Island (Figure D.2.10) is Ship's Harbour, facing the Letite Passage. This sheltered harbour is used as safe anchorage by boaters, and the gravel beach is commonly used for recreational picnics. MacMaster Island is the largest of the 40 small islands constituting the archipelago east of Deer Island, approximately 180 hectares. It contains one of the few saltwater ponds in the area, which is home to sticklebacks and mummichogs, and to the birds such as herons and kingfishers, feeding on these fish and the numerous small crustaceans. Eagles are routinely spotted flying across the beach; juveniles specifically seem to aggregate in springtime, if undisturbed. Transects performed by Lawton (1992, 1993) did not find any commercially significant species such as scallops or lobster, within the 10 m contour of the harbour. In the shallow waters of the harbour there are large numbers of sand dollars *Echinarachnius parma*, moon snails *Lunatia heros*, ridged neptunes *Neptunea decemcostata*, and the waved whelk *Buccinum undatum* (M-I. Buzeta, divelog, 2000).

West Isles region – The substrate here is mostly rock outcrop or boulders, except for sheltered areas where sand and mud predominate. The rocky substrate forms walls and overhangs that provide a complex habitat. Large macro-invertebrates abound on these surfaces, such as anemones, tunicates, and sponges. Ascidians are one of the hard substrate species found in this area. Specifically, the presence of two of the larger ascidian species, *Halocynthia pyriformis*, dominant above 20 m, and *Boltemia ovifera* dominant at 10-20 m and 80-90 m, indicate physical conditions related to hard substrate and moderate to strong currents. These provide habitat complexity, with species such as calcareous worms, hydroids and erect bryozoans attaching to the stalks of *B. ovifera* (Hatfield et al., 1992), and form a protective canopy where juvenile gadoids can be observed. (M-I. Buzeta, videolog, 2001). The larger sponge species, such as *Pellina* and *Halichondria,* further add complexity to the habitat surface, which provides refuge for lobster, crabs, juvenile cod, cunner, and tautogs. Sponge reefs are known to form bio-herms and observations suggest that they provide refuge for shrimp and small fish (Conway, 2000. In Stocker and Pringle, 2000). Structurally complex benthic habitats tend to be more sensitive to fishing disturbance; for example, sponge colonies found in the Gulf of Maine in 1987 were found to now be disturbed (Auster et al., 1996). In a study on the northern edge of the Grand Banks, Collie et al. (2000) found that disturbed benthic sites lacked epifaunal taxa, any colonial species, non-burrowing anemones, shrimps, sponges, nudibranchs, small fish, and some tube worms. Bottom fishing removes epifauna, reducing the habitat complexity that harbours small fish, reducing diversity and productivity. There are concerns with the spread of fishing effort to areas previously avoided, thus reducing refugia for species vulnerable to disturbance, including juvenile fish. Dragging effort for sea cucumbers in the West Isles occurs only as far as Parker Island (Figure D.2.18).

Species diversity and habitat complexity for this area has been reported in publications, during workshops, and through written submissions and personal observations. Hardie (1979) evaluated this area for diversity and abundance of invertebrates, and found species counts for the West Isles area include 836 invertebrates, 96 fish, 70 birds, 20 species of mammals, and 223 species of plants. The high currents in the area along with suitable habitats give rise to the high number of species. MacKay et al. (1978) reported on species diversity in the West Isles as part of a series of surveys to assess areas of significance for Parks Canada. His surveys indicate that some of the areas have a higher number of sessile benthic species (Figure D.2.22), and generally have the highest levels of diversity of benthic macro-invertebrates in the Bay of Fundy, and are considered ecologically unique. High species abundance/diversity ratings were recorded in areas around Hardwood, Adams, Simpson's, Sandy, Spruce, Tinker, Black Rock, and areas off Head Harbour and Deer Island Point (MacKay et al., 1978).

Lawton (1992, 1993) found that while some areas may sustain a moderate lobster population (e.g. Bean Ledges), there was no significant spawning aggregations found to date, but that berried lobsters are present during the summer months, widely dispersed among the rock wall, ledge, and boulder habitats fringing the islands. The Bean Island ledges contained a wide size range of lobsters, with a relatively moderate population abundance.

There are many sites that need further study to verify reports from fishermen, divers and educators. Crustaceans, as well as overall macrofaunal species density, are proven to be good indicators of minimally contaminated habitats (Chang, 1992). As such, the reefs and ledges around the West Isles still exhibit this quality. Distribution areas for species considered habitat indicators, such as sponges, soft corals, and *Boltemia*, are shown Figure D.2.23.

Barnes, Nubble and Mowatt Islands (Figure D.2.10 for location) are under Nature Conservancy of Canada protection. Nubble Island is the site of an easily viewed eagle's nest that is part of the local tour operators' points of interest. These islands also exhibit interesting benthic faunal assemblages, such as an *Edwardsia-Corymorpha-Coryphella* community found in shallow waters at Nubble Island. Here the nudibranch *Coryphella* feeds on, and lays its egg veils at, the base of the *Corymorpha* stalks. The geographically rare anemone *Edwardsia elegans* is present at this site (MacKay et al., 1978; M-I. Buzeta and M. Strong, divelogs, 2001). Boulders around Nubble Island support brachiopod communities, and the tunicates *Halocynthia pyriformis* and *Boltemia ovifera* are abundant (Thomas, 1983). Commonly found were horse mussels, large anemones *Metridium senile* and *Tealia felina*, with large sponges at the bottom of the ledges. Basket stars and scallops were also found. A large number of stalked ascidians (*Boltemia ovifera*) are found at Mowatt Island (Matfield et al., 1992), providing refuge for several species of juvenile fish (cod, pollock), and cunner *Tautogolabrus adspersus*. Spot dive checks performed in 1999-2001 verified that large numbers of juvenile cod are found at Mowatt Island amongst the refuge provided by the complex rocky habitat, and the attached stalked ascidians and sponges. Winter skate are also found in close proximity (M. Strong and M-I. Buzeta, videolog and divelog, 2001).

The western side of Simpson's Island (Figure D.2.10 for location) is relatively sheltered, with subtidal ledges and cliffs in the highly cleaved volcanic rocks. The site is used for intertidal and subtidal studies and by lobster fishers. There is an easily seen Osprey nest, and the shoreline is frequented by several eagles that feed along the shore. Simpson Island was brought to the attention of the Nature Conservancy of Canada by people who are concerned for its conservation (Appendix H).

Due to the presence of vertical rock walls and high current, Simpson's Island has a very diverse and abundant community of sessile organisms, significant from a marine conservation and recreational diving perspective, and appears to have higher species diversity than other sites surveyed by Lawton (1992, 1993). The western shore of Simpson's Island contains a stepped subtidal wall with considerable macro-invertebrate richness. Juvenile cod are commonly found amongst the rock crevices, along with the shallow-water inshore form of redfish *Sebastes fasciatus kellyi* (Scott and Scott, 1988). Local knowledge also suggests that this area is rich in benthic finfish, including small aggregations of winter flounder. In a study of subtidal transects at three different locations in the Quoddy Isles area, Logan et al. (1984) found that high densities of the anemone *Gonactinia* were found only at Simpson Island. The brachiopod *Terebratulina septentrionalis* was found consistently on its shaded cliff faces, and the highly cleaved rocks provided crevices for attachment of *Myxicola infundibulum*, which was most commonly found at this site. The Simpson Island area has a significant numbers of female harbour porpoise and calves (Smith et al., 1984).

Sandy Island (Figure D.2.10 for location) contains one of the few beaches in the area, composed of coarse sand. It is a popular recreational stop for boaters and naturalists, and is used by nearby communities and visitors for recreational activities such as picnics and swimming. Along the edge of the high water (supralittoral) there are gull nests. Common Eiders nest higher up among the low scrub. Along a transect running in a northeast to southwest direction, the sandy beach extends to a rocky reef, the habitat types changing from sand to mixed sand and fine sediment in a depositional area near shore, to cobble, and finally to a complex boulder and shelving reef habitat with numerous crevices and overhangs, in the area exposed to a high currents at the tip of the reef (Buzeta, 2002 divelog). Along with these physical changes are the characteristic species associations, thus it exhibits both physical and biological diversity. A herring weir is located next to shore, and the soft sediment around it is populated with a number of large *Cerianthus borealis* specimens. Sandy patches are also found here, populated with fields of *Corymorpha pendula*, and the rarely spotted burrowing cucumber *Sclerodactyla* sp. Epibenthic macroinvertebrates on sand also include the small burrowing anemone *Edwardsia elegans*, the nudibranch *Aeolidia papillosa*, and hermit crabs (MacKay et al., 1978; M-I. Buzeta, videolog, 2001). Soft corals *Gersemia rubiformis*, commonly called strawberry grounds, are found abundantly in the shallower areas of the reef. Fishermen recognize these "strawberry grounds" as good for lobster fishing, and their value as a component of benthic habitats for other species including lobsters, is recognized by scientists. Like the hard corals, soft corals appear to provide some three-dimensional structure to fish habitat, but may prove to be more resilient to some disturbance (Willison, December 2000, Fundy Forum Timed discussion). The tunicate *Halocynthia pyriformis*, and starfish and flounder, are common in the cobble areas. The species assemblage quickly changes with proximity to the end point of the reef. Here, species characteristic of a hard substrate, high tidal velocity habitat abound: large tunicates *H. pyriformis* and *Boltemia ovifera,* and massive sponges. Habitat complexity is high, sponges providing further habitat for small isopods and starfish. The underside of rockfaces are covered with *Terebratulina septentrionalis*, which characterize this habitat type as described by Logan and Noble (1971) and Noble et al. (1976). Lobsters, redfish (*Sebastes faciatus kellyii*), herring, pollock, juvenile cod and the tautog *Tautoga onitis* are commonly observed (M-I. Buzeta, videolog, 2001). Lawton (1992, 1993) suggested that the marine conservation significance of this area should be further evaluated because of its diverse sessile benthic filter-feeding community associated with a steeply shelving rock wall.

Nearby Tinker Island is a cormorant nesting site. Porpoise, finback and minke whales travel between these islands (Gaskin, 1979).

Casco, Spruce, White Island (Figure D.2.10 for locations) have steeply inclined rock faces and many boulders. The high tidal ranges flowing through the constricted passages result in high tidal current velocities. In most cases these velocities are still sufficient around the islands to prevent significant sedimentation. Cliff faces showed an abundance of bryozoans, anemones, sponges and brachiopods, while overhangs are dominated by *Terebratulina septentrionalis*. The deeper zones studied (18 m) showed the greatest species richness including sponges, hydroids, anemones, brachiopods, and tunicates The distinctive sublittoral hard substrate communities are that of *Terebratulina septentrionalis* and that of the crustose coralline algae *Lithothamnion* sp (Logan et al., 1984). Species distributions in this region, primarily of intertidal and subtidal macroinvertebrates, are described (presence/absence) by MacKay et al. (1978). Due to the presence of vertical rock walls and high current on the eastern side of the island, a very diverse and abundant community of sessile organisms is found along Casco Island. These communities are significant from a marine conservation and recreational diving perspective. These locations appear to have higher species diversity (Casco Bay and Simpson Islands), and Casco has an "impressive array of marine life" (Lawton, 1992, 1993). Spot dive checks were performed in 1999-2001 (M-I. Buzeta, videolog, 2001) to verify local knowledge regarding the diversity of the site and the presence of juvenile cod and wolffish pairs. Video and still cameras captured a diverse community, with large numbers of sessile invertebrates, juvenile cod, pollock, lobsters, and wolffish. The soft coral *Gersemia* is abundant at shallow depths along the length of the wall. In 1975 Parks Canada (1985) specifically identified the subtidal areas around Adams, Spruce and Casco Islands as proposed underwater trails, due to the high diversity of benthic invertebrates in these sites.

In 1982, Hunter and Associates (1982) proposed that the Head Harbour area be designated as an Ecological Reserve. At a Marine Protected Areas discussion session at Coastal Zone Canada 2000 (Chopin and Wells, 2000), participants concluded that there is sufficient information out there for "some" cases to be protected. An example given was Head Harbour, because of the marine mammal aggregations and migration paths for many species of seabirds (reference given for this was Gaskin, and the Pittsburg oil refinery hearings, *in:* Scarratt, 1979). Burt (1997) describes the Head Harbour area as being of importance because of the high concentrations of harbour porpoise, as seen previously in Figs. D.2.16 and D.2.17. There are several herring weirs in the area (Figure D.2.21), and a lighthouse station on Campobello Island. This is a major feeding area for large numbers of Red-necked Phalaropes, a species of concern due to the steep decline from unknown causes, and Bonaparte's Gulls in fall and early winter (Diamond, 2001, Appendix H). Diamond (2001, Appendix H) suggests that increased awareness amongst users is needed. He also recommends a limit on rockweed harvesting, and restricting salmon farming to areas that are not as sensitive. Logan (2001, Appendix H) suggests that the Head Harbour area should be protected. There is a tremendous volume of water that passes through, and the benthic biota are diverse and abundant. Subtidal transects of the Head Harbour area (Logan et al., 1984) showed a profile that drops precipitously to 13 m. Hydroids were most abundant here, and at nearby Casco Island. The community is described by Logan (1988) as lacking coralline algae, and being abundant in *Tubularia* hydroids, the anemone *Tealia felina*, and the horse mussel *Modiolus modiolus*.

White Horse Island is a small island, less than 5 ha. It is located 4.2 km east of Deer Island, 5 km North, northeast, of East Quoddy Head, Campobello Island (Figure D.2.10). The island is an important nesting area for guillemots, gulls, a large colony of Double-crested Cormorants *Phalacrocorax auritus*, and possibly the Northern Gannet *Morus bassanus*. It is a newly colonized breeding site of Black-legged Kittiwakes *Rissa tridactyla*, and guillemots (Figure D.2.15). Nearby sightings of over a dozen mature and immature puffins, and a 1999 photo confirmation of a nesting pair of puffins and gannets, make this the most southerly nesting site for puffins and the most coastal site for gannets. Sightings of Parasitic Jaegers (*Stercorarius parasiticus*) are also photo confirmed. Diamond (2001, Appendix H) recommends that this island should have protected status. Although few grey seals *Halichoerus grypus* are seen in southwest New Brunswick, they have been occasionally spotted off the ledge at White Horse (M. Strong, logbook, 2001).

The Wolves are a group of exposed islands composed of the largest East Wolf, Gull Rock, Flat Wolf, Fatpot and South Wolf (Figure D.2.24). Hard substrate predominates, with ledges and boulders, and some sandy areas. This is quite evident from the predominance of bedrock along the shorelines. The sizes of the islands range between 75-240 ha. There is a lighthouse station and several small dwellings on East Wolf, occupied for the purpose of tending the nearby herring weirs (Figure D.2.25). Water quality is thought to be high, with no nearby sources of pollution. Because of the low level of suspended matter, visibility ranges from 20-40 ft., and this is reflected by the algal growth to depths of 50 ft (MacKay et al., 1979; M-I. Buzeta, divelog, 2001). Bedrock provides suitable substrate for intertidal rockweed and subtidal kelp (Figure D.2.25). The entire intertidal area around The Wolves (some 35 hectares) has been set aside as a rockweed study site (Semple, per. com., 2001). MacKay et al. (1979) related the species assemblages around The Wolves by substrate type: rocky, mixed, and muddy/sandy. Rock substrates typically had large numbers of the seaweeds *Ascophyllum*, *Alaria*, *Laminaria*, *Agarum*; sponges such as *Haliclona* and *Halichondria*; ascidians such as *Boltemia*; horse mussels, and brachiopods. This substrate accounted for 65% of the species that could be counted *in situ* by divers. Mixed substrates (cobble, sand, mud, and gravel) commonly had an abundance of urchins, the common starfish, and hermit crabs. Mud/sand substrates showed a much lower species count, the most common species being the hydroid *Corymorpha*. High species diversity areas are shown in Figure D.2.26. Distribution and abundance of benthic invertebrates is comparable to the Head Harbour area, and there are suggestions that such diverse areas contribute significantly into adjacent important fishing areas (McKay et al., 1979). The area around Eastern Wolf Island is dragged for scallops and two sites in Southern Cove are considered as periwinkle harvesting areas (FigureD.2.27). Spawning lumpfish are commonly seen amongst the rocky areas (M. Strong and M-I. Buzeta, divelog, 2000). Depths of 100 ft occur very close to shore. As a result, pelagic fish, mammals and seabirds, are seen in close proximity to the islands; a mako shark was recently caught at a weir in The Wolves (Benjamin, 2001, Appendix H). Currently this area is fished extensively, and some ecotourism occurs: whale and bird watching, and some recreational diving. There is evidence that harbour porpoise in the Bay of Fundy may be overexploited, and Trippel et al. (1996), suggest that substantial reduction in by-catch may be achieved by reducing gillnet effort in two small areas, The Wolves area being one of them.

Hunter and Associates (1982) have identified the Wolves as a Regionally Significant area because it is a feeding and staging area for ducks, shorebirds, and pelagic seabirds. It is a major breeding area of Common Eiders, and an important wintering area for the endangered Harlequin Duck *Histrionicus histrionicus* (Diamond, 2001, Appendix H; Brylinsky et al., 1996). Some fifty pairs of Harlequin Ducks and eiders nest on The Wolves. The colonies of Black-legged Kittiwakes (100 pairs of kittiwakes in 1995) make The Wolves the southern most colony in North America. There is also a handful of Razorbills on South Wolf, which is a new colony in recent years. Also present are Bald Eagles and cormorants (Mawhinney and Sears, 1996; Diamond, 2001, Appendix H).

The Letang Estuary has several large islands at the mouth that provide protection from waves for Back Bay, Letang Harbour and Bliss Harbour (Figure D.2.28). Shoreline classification (Figure D.2.29) shows the outer portions of the Letang as bedrock, while the inner portions are almost entirely comprised of mud tidal flats. The substrate types present in the area provide suitable habitat for soft-shelled clams and scallops, and significant (principally immature) lobster population inhabits the area (Figure D.2.30). The Letang Peninsula, along with Beaver Harbour, showed one of the highest juvenile lobster densities during the survey dives in the Quoddy Region, and reflect a prime recruitment habitat for lobsters (Lawton, 1992, 1993). The area supports a sea urchin fishery and a periwinkle fishery (Figure D.2.31). There are several dulse harvesting areas, and most of the islands and narrow passages in the area are lined by bedrock which extend under water to provide suitable substrate for kelp, as well as haulout sites for harbour seals (Figure D.2.32). MacKay et al. (1979) conducted a series of spot examinations in the area. The outer areas of the Letang Peninsula had the highest number of species, as well as the areas of high productivity as indicated by abundance/diversity ratings (Figure D.2.33). A relatively high fish abundance, including several large wolffish, was noted in the subtidal areas. The protected nature of the area attracted the development of aquaculture, and this area is presently of high importance to the industry (Figure D.2.34). This area has been designated by the Province as a controlled aquaculture growth area. Most of the herring weir fishery has been concentrated in the outer Letang Peninsula.

Maces Bay area

Shoreline classification for the area between Beaver Harbour and Point Lepreau, and location of names discussed, are shown in Figure D.2.35.

The Maces Bay area was identified as Regionally Significant by Hunter and Associates (1982) because of its significance to feeding and breeding sea ducks, Brant (*Branta bernicla*), shorebirds, gulls, terns and cormorants (Figure E.14). King Eiders (*Somateria spectabilis*) are rarely seen in the Bay of Fundy, but have been recorded in Maces Bay (Brylinsky et al., 1996). The intertidal ledges are recognized as important staging areas for Brant during their spring migration. Thomas (1983) reported that is a good area for inshore marine birds, as the rocky tidepools attract migrant shore birds in late summer, Purple Sandpipers (*Calidris maritima*) in winter, and Brant in spring. Gulls and other seabirds breed on the Salkeld Islands. Diamond (2001, Appendix H) points out the importance of areas along the coast of Point Lepreau west to Red Head, including Salkeld Islands in Maces Bay, and New River Island in Pocologan Harbour. There are important nesting colonies of Common Eiders on Salkeld and New River islands, and important brood-rearing habitats (rockweed along mainland shore). The supralittoral areas provide critical habitat for nesting for Common Eiders. New River Beach is a designated as a Provincial Park; and New River Island is a private nature reserve. Eastern Habitat Joint Venture has purchased some coastal islands for protection, like the Brothers Islands near New River (Richard, 2001, Appendix H). Maces Bay/Point Lepreau area has been designated an Important Bird Area (IBA) (Figure E.14). Each spring and fall, tens of thousands of seaducks, including Common Eider and Black Scoter (*Melanitta nigra*), travel through this area. The IBA program is delivered by the Canadian Nature Federation working with local community groups to conserve wildlife and habitat on private lands.

The ledges in the Maces Bay area provide ideal haulout locations for seals (Figure D.2.36). Lawton (1992, 1993) describes several transect surveys performed in this area. The purpose of these dive transects was specific to the identification of sensitive nursery and spawning habitat for lobsters, however they also recorded detailed observations on the benthic habitat and community. Within Maces Bay, Pocologan Island and French Ledges showed good juvenile lobster densities. Large, mature, lobsters (> 100 mm carapace length) were located in the deeper waters, while juveniles were predominantly found in shallower waters (Figure D.2.36). In particular, the Pocologan Island-French Ledges area contained significant numbers of juvenile lobsters. The New River Beach-Barnaby Head area had a preponderance of immature lobsters, indicating that the area is an active settlement location. Relative abundance of lobsters in the Barnaby Head-Lepreau Harbour area indicates that the area is a prime lobster nursery habitat. Some evidence was found that this area may be used by berried female lobsters, as some were found during one transect along the eastern side of the French Ledges, and the southwestern side of Mole Island. As well, on the north side of Mole Island, depressions found in the sand were interpreted by experienced biologists to be those of berried females. Several berried lobsters were also encountered during survey dives off the exposed areas of the Brothers Islands, and around Point Lepreau. These areas are very exposed, and the substrate is sand and gravel at the deeper areas, and boulders and flat ledges in shallower waters. It seems unlikely that Maces Bay would have the same significance as Flagg Cove (Section D.1) as a spawning location, given the limited evidence. However, Lawton (1992, 1993) does suggest its significance as a lobster and scallop nursery area. He summarizes that the principal area for lobster productivity is the coastal area, ranging from outside the Passamaquoddy Bay area to Maces Bay. More recently, anecdotal observations by experienced research divers were that densities of small juvenile lobsters in that area were very high (Lawton et al., 2001). In an unpublished report, Lawton (2002) recommends that Maces Bay should be designated as an aquaculture exclusion zone.

MacKay et al. (1979) analyzed productivity in this area as related to the abundance of benthic invertebrates (Figure D.2.37), and concluded that it was not as high as the West Isles or The Wolves. Chopin et al. (2001, Appendix H) identified the importance of maintaining research/monitoring sites for diversity of seaweeds, as these are useful bioindicators. Two of these sites are located in Maces Bay, in Welch Cove and Lepreau Harbour (Figure D.2.38). Their concern is that these areas, and Maces Bay generally, are threatened with nutrification, siltation, and eutrophication, of coastal waters (Bates et al., 2001, Appendix H). They give several management recommendations specific to these seaweed study areas: the sites are relatively small, but should be part of the network of areas with enhanced management or protection, for they are needed in long-term studies. These reference sites should be kept with a minimum of anthropogenic impacts.

MacKay et al. (1979) points to a very active fishery in the area, with scallop, herring, lobster and groundfish areas within, or in close proximity to Maces Bay. Data from Community Coastal Resource Mapping (CCRM, 1999) also substantiates the abundance of scallops and soft-shelled clam beds in the area (Figure D.2.39). High scallop spat densities were observed by Lawton (1992, 1993) in the areas around Brothers Island and off Barnaby Head. Periwinkle and sea urchin harvesting areas are also shown in Figure D.2.39. The Maces Bay area traditionally had several productive herring weirs, as recorded by CCRM (1999). More recently it has become the site for several aquaculture developments (Figure D.2.40), including the conversion of some of these weirs to aquaculture.

3. NEW BRUNSWICK SHORE – VARIOUS

Because of the availability of suitable substrate, production estimates for seaweeds along the New Brunswick side of the Bay of Fundy are higher than along the Nova Scotia side. The estimate for seaweed production on the rocky shores of the inner and outer Bay of Fundy is 850 g C /m^2 (Brylinsky et al., 1996). On the New Brunswick side, there have been several areas reported as significant from the perspective of abundance of juvenile lobster or scallop spat (Lawton, 1992), some of which may already be under influence of industrial marine developments. McKenzie (1934) reported several cod spawning areas along the New Brunswick shore from Passamaquoddy Bay, to above Saint John (Figure E.1). Egg counts in May (1932) included some of the highest found in the Bay of Fundy, although several locations south, along the Maine coast, also showed high cod egg counts. However, current data suggests that these areas are now extinct (Graham et al., 2001).

Shoreline classification and locations of areas discussed for the New Brunswick coast between **Point Lepreau and Saint John Harbour** is shown in Figure D.3.1. The shoreline classification between Point Lepreau and Saint John Harbour indicates 8 sections of shoreline that have marshes (Figure D.3.2). Griffin (2001, Appendix H) submits concerns regarding protection of small marshes, in particular the Hazen Creek Marsh in Saint John, NB. He gives an example of the increasing pressures placed on marshes in the area, a point also relevant to many of the small marshes distributed throughout the Bay of Fundy (Figure C.11) The presence of bedrock along the shoreline provides good locations for seal haulouts as indicated from the 1986 aerial surveys by Terhune (2001, unpublished) and by CCRM (1999) (Figure D.3.2). Soft sediment along the coastline provides suitable substrate for soft-shelled clams and scallop beds (Figure D.3.3). The rocky subtidal areas provide substrate for sea urchins and the rocky intertidal (boulders and bedrock) provides habitat for high periwinkle densities. The locations of sea urchin and periwinkle harvesting sites and a rockweed study site are shown in Figure D.3.4. Neish (1973) reported the locations of various seaweeds, and while the brown algaes (for example *Laminaria*) were well represented in this coastal area, the green algaes (such as *Ulva or Enteromorpha*, were not found in the sampled areas (Figure D.2.41-44). Important Bird Areas in the Bay of Fundy as listed on the IBA web site (Figure E.14) are Manawagonish Island, Saint Rest's Marsh and Beach. The shortnosed sturgeon population is largest in eastern North America (Dadswell, 1979, in Gordon and Dadswell, 1984), and Atlantic sturgeon *Acipenser oxyrinchus oxyrhinchus*, is common in the upper Bay of Fundy in the summer (Gordon and Dadswell, 1984). Short-nosed sturgeon, Atlantic sturgeon, and Atlantic salmon are all present in the Saint John Estuary (Litvak, 2001, Appendix H; Percy et al., 1996). This river demonstrates the highest records for diversity of anadromous and diadromous species in Bay of Fundy streams and rivers. Fifteen species, ranging from sea lamprey, sturgeons, alewife, shad, smelt and sea bass have all been recorded here, as compared to other New Brunswick Rivers which range from 0 (Mispec and Letang Rivers) to 10 (St. Croix Estuary) (Hunter and Associates, 1982)

Musquash

In 1957, Wein and Jones had suggested Musquash as a terrestrial ecological reserve because of its significance as a characteristic example of a salt marsh ecosystem along the coast. The size given was 1615 acres. Hunter and Associates (1982) have also identified it as a Regionally Significant area (Figure E.15). The Musquash marsh is classified as a Class I salt marsh (Roberts, 1993). Class I marshes are large with a known or assumed high value to wildlife, and represent the highest priority for protection and management. This area has been described by the Conservation Council of New Brunswick (CCNB) as one of the last ecologically intact estuaries in the Bay of Fundy (Harvey et al., 1998; Platt, 1998). Because of their significance, and for their value as waterfowl habitat, marshlands around Musquash, which are available for acquisition, are being pursued by the Eastern Habitat Joint Venture (Richards, 2001, Appendix H), and by Nature Conservancy of Canada (Maillett, 2001, Appendix H) in order to achieve their protection. Thomas (1988), and more recently Singh et al. (2000) summarized detailed ecological information available on Musquash. Thomas (2001, Appendix H) identified Musquash Head as a significant area which has been used for research and teaching for a long time, and that should be protected. Musquash Head is an unremarkable area in terms of its ecology, but it is a remarkable example because it has not been adversely impacted. There is no single species of importance, but rather Musquash Head is an example of a typical rocky headland community. The ecology of the area is complex and the whole area is worth protecting. Musquash Harbour, the salt marshes, the head of the harbour, Musquash Head, and Gooseberry Island have received a lot of scientific attention.

MacKay (1974) recorded the number of species and determined that the areas of high abundance ratings were to be found at the entrance to Musquash Harbour (Figure D.3.5).

On February 8, 2000, the Department of Fisheries and Oceans announced publicly that the Musquash Estuary had been accepted as an Area of Interest, the first milestone in the official Marine Protected Areas (MPA) process. Boundaries for the proposed MPA include all the subtidal and intertidal area inside a line drawn from Musquash Head through the southern tip of Gooseberry Island and extending to the coastline at the western tip of Gooseberry Cove (Figure D.3.6). The inland limit will be the head of the tide at the Musquash Hydro Station. The estimated total area of the MPA is 16.56 sq km, 6.39 sq mi). The overall objective of the management plan will be the *"Protection and restoration of the Musquash Estuary and surrounding salt marshes."*

The shoreline classification between **Saint John Harbour to Alma**, and place names discussed below, are shown in Figure D.3.7. There are several salt marshes identified (Figure D.3.8), but hard substrates are the most common, in particular around the Point Wolfe area. Soft sediment along the coastline provides suitable substrate for soft-shelled clams and scallops (Figure D.3.9). Community Coastal Mapping Resource Data (CCRM, 1999) identified a coastal lobster spawning area between Quaco Head and Martin Head, and Daborn and Gregory (1983) found the presence of juvenile lumpfish *Cyclopterus lumpus*, during July and October (Figure E.8). The rocky subtidal areas provide substrate for sea urchins and the rocky intertidal (boulders and bedrock) provide habitat for high periwinkle densities; locations of harvesting sites for both of are shown in Figure D.3.10.

Fundy National Park (Figure D.3.7) includes examples of two coastal environments, as defined by Owens (1977): Chignecto Bay's sandstones and shales with expansive intertidal mudflats and the North Shore's sedimentary cliffs with a few beaches. Two small salt marshes are located at Point Wolfe and on the edge of the Alma River. At the higher end the marshes are dominated by *Spartina alterniflora* and *Nereis diversicolor*. *Macoma* and *Corophium* dominate the lower, muddier portions of the marshes. Intensive studies have been done in areas around Alma, Herring Cove and Point Wolfe (Carter and MacGregor, 1971). Forty-seven algae species, 85 invertebrate taxonomic groups, 7 fish species and numerous shore birds were listed during studies of the intertidal zone. The park boundary stops at the mean high tide line.

4. INNER BAY OF FUNDY

Chignecto Bay

Place names for Chignecto-Shepody and Cumberland Basin areas are shown in Figure D.4.1. Erosion processes along a southwest-northeast direction created this area. The intertidal sediments (Figure D.4.2) are mainly mud, provided by the erosion of the coastal outcrops of glacial deposits and the unresistant sedimentary rock cliffs. In sheltered areas there are extensive marshes, especially at the head of Cumberland Basin and Shepody Bay (Owens, 1977).

Chignecto Bay was identified by Hunter and Associates (1982) as an area of Regional Significance to dabbling ducks, sea ducks, shorebirds and mergansers, and is listed as an important bird area (Figure E.14). Aerial surveys in 1971 commonly spotted Canada Geese (*Branta canadensis*) in Shepody Bay (Brylinsky et al., 1996). Hicklin and Smith (1984) reported the distribution of several bird species, and these are shown Figs. E.13. At a workshop in 2001, Hicklin (2001, Appendix H) stated that these biologically rich mudflats require legislated protection, as they are critical as a foraging/roosting area for the world population of the Semipalmated Sandpiper during their southward migration. He recommends declaring the intertidal zone of the Bay of Fundy as a conservation area protected by the federal and provincial governments of New Brunswick and Nova Scotia. Significant areas identified by Majka (2001, Appendix H) and Davidson (2001, Appendix H) include New Horton, Daniels Flats and Johnson Mills. These areas are being pursued for acquisition by Canadian Wildlife Service for protection of shorebirds. Chignecto Bay is a Western Hemisphere Shorebird Reserve, and includes the Chignecto National Wildlife area.

The distribution of major taxa of invertebrates is shown in Figure D.4.3; the outer part of Chignecto is dominated by polychaetes and molluscs, while the inner part is mostly polychaetes (DFO Virtual Data Centre, 2001). Large lobsters migrate into Chignecto Bay in the summer months to molt, extrude new eggs or release larvae, and it may be an important spawning area (Campbell, 1985). Scallop and soft-shelled clam beds, and urchin distribution in the area were identified by coastal communities in 1999, and are shown in Figure D.4.4.

The Grindstone Island / Mary's Point peninsula (Figure D.4.1 for locations) is a well-known area located in Shepody Bay, upper Bay of Fundy. The upper parts of the island are covered with coastal forest; and the beaches, sand dunes and ledges, are connected with extensive mudflats and marshes (Majka, 2001, Appendix H). Hunter and Associates (1982) proposed the area as an Ecological Reserve. This area has already been designated a Ramsar Site and a Western Hemisphere Shorebird Reserve. A portion of it is located within the Shepody National Wildlife Area. This recognition, however, does not infer any legal obligation for protection. Critical/significant habitats described by Majka (2001, Appendix H) include: the extensive intertidal mudflats that harbour a variety of invertebrates which are the source of food for migrating shorebirds; the tidal marshes of which only a very small portion is protected within the National Wildlife Area; the intertidal ledges that harbour a great variety of marine life; and Grindstone Island, recognized as having ecological significance because of its large colony of Great Blue Herons (Majka, 2001, Appendix H; Davidson, 2001, Appendix H), and as a breeding area for Double-crested Cormorant, Common Eider, Great Black-backed Gull (*Larus marinus*) and Herring Gull. Majka (2001, Appendix H) recommends some form of permanent arrangement to protect the area's ecological integrity against environmental concerns that include the extraction of bait worms, recreational mud sliding, alteration of marshes, siltation of ledges by nearby dredging, and lumbering of the shorefront.

Shepody Bay is one of the key focus areas for Eastern Habitat Joint Venture land acquisitions to ensure the protection of salt marshland (Richard, 2001, Appendix H).

The upper Bay of Fundy is probably the most important bird area in eastern North America for migrating shorebirds (Hunter and Associates, 1982), and Mary's Point is considered the most important migration site for Semipalmated Sandpipers in eastern North America (Hicklin, 2001, Appendix H).

Minas Basin

There are four regions within Minas Basin (Figure D.4.1): the Channel at the mouth, including Cape Chignecto, Cape Split, Scots Bay, and nearby Ile Haute; the central portion of the Basin, including Parsborro and Five Islands; Southern Bight where Evangeline Beach is located; and Cobequid Bay with the Salmon and Shubenacadie Rivers (Percy, 2001).

The basin is typically comprised of sandy estuaries and sand flats, as a result of the erosion of the sandstone cliffs, and from seabed sediments imported into the basin transported counter-clockwise to the north (Gordon and Dadswell, 1984). Tides average 12 m (Percy et al., 1996), depth at low water is commonly under 25 m. A tidal velocity Vmax of >400cms^{-1} has been recorded by Wildish et al. (1986) for Cape Split in Minas Basin. Cliff sides composed of siltstone and shale surround Minas Basin, and as a result of wave action there is a large amount of fine sediments in suspension, which in turn accumulate on expansive mudflats (Gordon and Dadswell, in Percy et al., 1996). The area encompasses about 100,000 ha, and more than a third of the area is tidal mudflat. There are a large number of small saltmarshes scattered along the coastline; locations of these are shown in Figure D.4.5.

Mudflats are identified by Hicklin (2001, Appendix H) as significant areas for birds and are shown in Appendix H. The most abundant resident infauna is the amphipod *Corophium volutator*, the clam *Macoma baltica*, and the snail *Ilyanassa obsoleta*. Large numbers of migratory birds arrive in late July, and forage upon *Corophium*, which in turn grazes on diatoms, resulting on an increase in diatoms and chlorophyll content of the sediment. Mudflat diatoms contribute half of the primary production, with phytoplankton and salt marshes contributing the rest (Percy et al., 1996). Southern Bight is a biologically rich mudflat which Hicklin (2001, Appendix H) believes requires legislated protection. It is a critical/significant habitat as a foraging/roosting area for the world population of the Semipalmated Sandpiper during southward migration to the wintering grounds. The largest numbers of Black Ducks in the Bay of Fundy have been recorded in Minas Basin (Brylinsky et al., 1996, in Percy et al., 1996). Spencers Island, Cape d'Or, Southern Bight-Minas Basin and Cobequid Bay are all listed as Important Bird Areas in the Bay of Fundy (IBA Website, see Figure E.14).

Striped bass are known to spawn in the Shubenacadie River, and the winter run of tomcod attracts the Bald Eagle, making this an important wintering area for the Bald Eagle (Hicklin and Smith, in Gordon and Dadswell, 1984).

Plankton tows performed between July and October 1983 found juvenile lumpfish at Cape Chignecto, and the Minas Channel and Nova Scotia coast (Daborn and Gregory, 1983). Shad, alewives and other fish feed on the swarms of mysid shrimp along the muddy bottom. *Corophium volutator* are abundant. Data on distribution of macro-invertebrates suggests that their predominant biomass is composed of molluscs, such as the clams *Mya arenaria and Macoma baltica* (Percy, 2001), and crustaceans (DFO Virtual Data Centre, 2001). Sea urchins are most commonly distributed around Cape Chignecto and into Greville Bay, and along the Nova Scotia coast of the Minas Channel (Figure D.4.4). Clam beds are found in the predominantly muddy intertidal areas in Minas Basin, and scallop beds are located in Minas Channel, outside of Cape Split.

Minas Basin is a Western Hemisphere Shorebird Reserve and has been named an important conservation area by the Department of Natural Resources in Nova Scotia, and it is also a Ramsar site (Figure C.14). Environment Canada is interested in proper management of this area, because of the potential negative impacts on birds and fish. And a number of universities conduct long-term research programs particularly in the intertidal zone. There are concerns regarding the harvesting of the baitworm, *Glycera*, an important prey species to Black-bellied Plovers *Pluvialis squatarola* (Shepherd et al., 1993, in Percy et al.,1996). Management recommendations listed by participants at a 2001 workshop (Appendix H) included declaring the intertidal zone of the Bay of Fundy as a conservation area, protected by the federal and provincial governments of New Brunswick and Nova Scotia. Willison et al., (1997) identified the Minas Basin mudflats as a potential Marine Protected Area because they support such a wide variety of shorebirds, and because of the concern over the unregulated blood worm industry.

The Scots Bay (Figure D.4.1) sand wave field was identified by Miller and Fader (1990). This is considered a geologically unstable, and easily mobilized, top layer of sand, with a more stable, underlying gravel substrate. This large deposit of coarse sand and fine gravel is of interest to the mining community. Concerns about the extraction of this sand layer have been expressed regarding potential impacts on herring spawning grounds, the significant impact on benthic organisms, coastal erosion and the formation of benthic sediment plumes (Percy et al., 1996). Herring spawning at Scots Bay had been reported by Leim (1931), and later by Iles and Sinclair (1982) and Kozak (in Gordon and Dadswell, 1984). Bradford and Iles (1992) state that there is strong evidence that the early life history of Minas Basin herring is completed within the basin. Ichthyoplankton surveys in 1983 and 1984 located the largest numbers of larvae in the basin near the beginning of Cobequid Bay (Figure D.4.4). Stephenson et al. (1999), documented large numbers of herring spawning near the entrance to Minas Basin and along the Nova Scotia shore, as well as historical spawning sites in Minas Channel (Figure E.5). Willison et al. (1997) suggest the protection of spawning areas for local stocks, such as that in Scots Bay. Weirs in this area have been known to catch large specimens of windowpane flounder *Scophthalmus aquosus*, and large catches of winter flounder, *Pseudopleuronectes americanus*, were sampled in a bottom trawl (Dadswell et al., in Gordon and Dadswell, 1984)

In 1985 Parks Canada identified the **Evangeline Beach** as a Marine Natural Area of Canadian Significance (Figure D.4.5). The shorebird habitat around Minas Basin, and specifically Evangeline Beach, have been brought to the attention of Nature Conservancy of Canada because they show ecological significance, and landowners wish these properties to be protected (Maillett, 2001, Appendix H). Boot Island National Wildlife Area is a significant blue heron habitat. Its location, just off Evangeline Beach, is shown Figure D.4.1.

The estimated area of marsh distribution in the Bay of Fundy is the highest in Southern Bight, 2,037 ha. Production by the amphipod *Corophium volutator* in the Bay of Fundy, which attracts large numbers of migrating shorebirds (Brylinsky et al., in Percy et al., 1996), is highest at the Evangeline Beach, Southern Bight. The 1978 estimates are over 3 g Carbon/m^2 for the Evangeline area, as compared to 0.26 in Minas Basin, and 1.6 for Shepody Bay (Peer, in Gordon and Dadswell, 1984).

Because of the ecological significance of the Minas Basin area, several approaches to management have been proposed. **The BOF Ecosystem Partnership, Minas Basin Working Group** consists of federal, provincial, academic and local experts working to identify significant habitats in that area, as a basis for management planning. The project is aimed at protecting biodiversity and identifying natural resources and threats. One of the objectives of this group is the development of an integrated management plan for the Minas Basin. (Brylinsky, 2001, Appendix H). Preliminary work has so far resulted in a Minas Basin bibliography, a database of all interested parties, a list of stakeholders and communities, and a list of conservation issues. One of the issues of particular concern is the sensitivity of the Minas Basin environment (Musselman, 2001, Appendix H).

In July 1997 the Nova Scotia Museum undertook an expedition to **Ile Haute** (Figure D.4.1), and studied the terrestrial flora and fauna. The island is approximately 80 ha, and has been managed by the Canadian Coast Guard, Department of Fisheries and Oceans, but it is now being sold. The Canadian Wildlife Service is always interested in acquiring any land that contains salt marsh, and Ile Haute is of interest for the bird colonies (Davidson, 2001, Appendix H). The island is home for a number of birds and is the site of nesting Peregrine Falcons (*Falco peregrinus*). Common Eiders breed on the island (Brylinsky et al., *In* Percy et al., 1996).

There is little information on the marine biota surrounding the island. Figure D.4.3 includes the information on marine invertebrates in the Ile Haute vicinity, and Figure D.4.4 shows the Community Coastal Resource Mapping (1999) information on the distribution of scallop beds surrounding the island.

The Marine Conservation Biology Institute (MCBI website, 1999) identified Ile Haute as one of the areas of "highest priority" for protection (Figure E.17), and is considered a relatively undisturbed coastal island.

The Upper Bay of Fundy UNESCO Biosphere proposes a healthy balance between human activities and nature; as communities would choose to foster economic sustainability, conservation of nature, and integrated management (www.unesco.org). Biosphere Reserves can provide a suitable co-operative framework for resolving some of the potential negative environmental impacts. The general location identified in 2002 by the proponents, The Bay of Fundy Product Club, was the Inner Bay of Fundy, shown in Figure D.4.6 (Eberhardt, per. com., 2002). Because the project is still in the formative stages, the planning committee is refraining from defining a definite area. However, as a starting point for discussion, the planning group is proposing the watershed and coastal areas of the New Brunswick side of the Inner Bay of Fundy, but hopes to encourage inclusion and participation from a broader area. A recently released information document (P. Etheridge, 2003 pers. com.) outlines the Inner Bay of Fundy Biosphere purposes:

- The conservation of landscapes, ecosystems, and species and genetic variation.
- The promotion of economic growth at the local level.
- The promotion and guidance of research, monitoring and education on conservation issues.

5. NOVA SCOTIA SHORE – VARIOUS

Place names can be located in Figure D.5.1. Shoreline classification for the Nova Scotia shore of Bay of Fundy is not available in line form, but point descriptions obtained through Community Coastal Resource Mapping (1999) are shown in Figure D.5.2. This information mostly shows areas with bedrock and cobble beach, with scattered saltmarshes.

The **Annapolis** area is sheltered and has an extensive salt marsh development. During a study of lobster distribution in September 1993 in Annapolis Basin, Lawton et al. (1995) found the highest numbers near Digby Gut. The lobster tagging study showed that the marked lobsters migrated outwards in the fall. (Figure D.5.3). Figure D.5.4 shows the total weight of infauna, as sampled by grabs in Annapolis Basin. Community Coastal Resource Mapping (1999) identified sea urchin distribution at Digby Gut, the scallop beds in the area, and the soft-shelled clam beds along the southern shore of the Basin (Figure D.5.5). In a report by the Fundy Fixed Gear Council (A. Bull, 2000, Pers. Com), fishermen suggested the closure of the Annapolis River to clam digging, recognizing the importance of this area as a clam spawning area, supplying the rest of Annapolis. A study of the scallop drag bycatch in the Digby area showed that the number of species (Figure D.5.6) found associated with scallops caught is fairly uniform (Magee et al., 1999).

Daborn and Gregory (1983) found juvenile lumpfish, inside Annapolis Basin and just out from Digby Gut, during plankton tows between July and October (Figure E.8). Percy et al. (1997) suggest that reports of Atlantic sturgeon juveniles and dead ripe females indicate that there may be a spawning population in the Annapolis River.

The number of lobsters observed per 1000 m^2 during dive surveys in **St. Mary's Bay** is shown in Figure D.5.7 (Lawton et al. 1995). Scallop beds, soft-shelled clam beds, and dulse harvesting areas (CCRM, 1999) are shown in Figure D.5.8. Sea urchin harvesting areas for St Mary's Bay and Brier Island were also identified by Community Coastal Resource Mapping (1999).

Locations of seal haulouts, herring weirs and aquaculture sites, from Digby to Brier Island, were identified by Community Coastal Resource Mapping (1999). There are several herring weirs located along Digby Neck. Aquaculture sites recorded at that time included culture of oyster, scallop, Atlantic salmon, trout, halibut, cod and flounder (Figure D.5.9).

Brier Island area

Brier Island is a relatively small island, approximately 4.4 miles long, and 5 square miles. The topography consists of rugged cliffs, as high as 100 ft., with small unprotected coves. It is located at the mouth of the Bay of Fundy, and is exposed to oceanic conditions, being affected by strong winds, surf and storms. Tidal currents sweep across shoals, as fast as 6 knots for Grand Passage (MacKay, 1977). This area represents one of two tidal pumps that support biological production (Percy et al., 1996). This tidally generated ecosystem is important for herring, birds, cetaceans, and the North Atlantic right whale (Dadswell et al., in Gordon and Dadswell, 1984). Several brackish ponds are found at **Pond Cove** (Figure D.5.10 for location). Principal species at Pond Cove are mummichogs *Fundulus heteroclitus*, sticklebacks, and gammarids.

This area was identified by Messieh (1992) as an important area during July and September, when wintering Greater and Sooty Shearwaters (*Puffinus gravis and P. griseus*) are feeding on dense swarms of euphausiids *Meganyctiphanes norvegica*, and for Wilson's Storm-Petrel feeding on copepods. Distribution studies of euphausiids in 1969 (Isles, in Gordon and Dadswell, 1984) show the highest concentrations are found in the Grand Manan Basin-Brier Island area, as well as the highest copepod diversity and concentrations.

During floodtide, plankton concentrations near Brier Island are forced to the surface, along with cool water, when encountering a series of steep underwater ledges (Brown et al., 1979). Tidal streams in this area reach 1.4 m/s (2.66 kt), presumably bringing up the cooler deeper waters to the surface. Copepods are brought to the surface with this strong upward water movement, and euphausiids follow, either passively brought upward by the same turbulence, or actively following this food source, to form large surface swarms. The food chain in this area includes these copepod and euphausiid aggregations, mackerel, herring squid, gulls, shearwaters and Red Phalaropes (*Phalaropus fulicaria*), and the cetacean megafauna (Smith et al., 1984). The phenomenon of surface swarming is considered significant to seabirds and baleen whales.

The Brier Island area is a very important feeding area for birds year round, and is listed as one of the Important Bird Areas in the Bay of Fundy (Figure E.12-14); Greater and Sooty Shearwaters (*Puffinus gravis* and *P. griseus*) and Red Phalaropes are numerous off Brier Island in the fall during migration. (Hicklin and Smith, in Gordon and Dadswell, 1984). Red-necked Phalaropes have diminished in numbers in the Quoddy Region since 1990, while numbers have been increasing in the Brier Island area. While the idea of an alternate staging ground has not been verified, it has been suggested that some of the birds are now going to Brier Island (Duncan, in Percy et al., 1996). MacKay (1977) lists the marine bird species observed during the December of 1976; the list includes fulmars, petrels and murres.

The island is surrounded by waters rich in marine life; it attracts humpback, finback and minke whales, white-sided dolphins, mackerel, squid, herring, and Red Phalaropes. The Brier Island Ocean Study historical data (1984-present) on sightings by whale watching tour boats, of cetaceans off Brier Island recorded ten different species in the month of August, and a total of 34,491 individual animals. Stephenson et al (1999) summarized the general area for whale observations for the Brier Island area (Figure D.5.11) in August for 1985-98. Seal haulout locations in Brier Island (CCRM, 1999) have been shown in Figure D.5.9. A study of porpoise by-catch by Trippel et al. (1996), showed that a large number of porpoise were caught in gillnets set off Brier Island.

A large number of fish species have been recorded for this area; these are listed in MacKay's (1977) report of Brier Island. Strong and Hanke (1995) demonstrated that the Brier Island - Digby Neck area has a finfish diversity >15 species per tow (1990-93 data) (Figure E.9). McKenzie (1934) in a study of cod egg distributions in the Bay of Fundy, Georges Bank and Scotian Shelf, reported that high numbers of eggs were found in the Brier Island - Digby Neck area, signifying this was a cod spawning area during January to April. Cod egg counts in this area in April were highest close to the coastline (Figure E.1).

The Brier Island shores along Grand Channel show a relatively high diversity of species assemblages, due to the mixed substrate of ledge, cobble, mud and sand. Kelp beds dominate around the island. MacKay (1977) assessed the significance and representativeness of this area within the Bay of Fundy, and recorded the number of species found during dive surveys (Figure D.5.10). His detailed report outlines the information available on the biological, oceanographic and economic aspects of the marine environment surrounding the island. MacKay (1977) shows the distribution of benthic macroinvertebrates in the area, and lists four sponge species observed during diver transects: *Halichondria panicea* (bread sponge), which was widely distributed, *Haliclona oculata* (finger sponge), found at only once site, *Isodictya deichmannae*, a very large sponge associated with horse mussels, and the small *Scypha ciliate* (sea vase sponge). On the sand/gravel substrate in the area, high *Modiolus modiolus* density was observed (Fuller et al., 1998). MacKay (1977) used indicator species to compare the Brier Island area with Deer Island and Grand Manan. He found that on this basis (and presumably excluding the Grand Channel area), it had a lower diversity of benthic macroinvertebrates than that found in the Deer Island area, but attributed this to the lower diversity of habitat types. Number of species caught as bycatch in scallop drags in areas near Brier Island and Trinity Ledge (Kenchington et al., 1999) are shown in Figure D.5.12. There were two aquaculture sites recorded at that time in Grand Passage, between Long Island and Brier Island (Figure D.5.9).

The shoals of northeast Brier Island were identified as a Natural Area of Canadian Significance (NACS) (Figure E.10). Willison et al. (1997) identified Brier Island as a potential location for a Marine Protected Area, because it is representative of important outer Bay features, and for its significant marine mammal and bird diversity. In 1999, the Marine Conservation Biology Institute (MCBI), a scientific and conservation organization, convened 21 Canadian and USA scientists in order to identify "highest priority areas for protection." Brier Island was one of the areas identified in Bay of Fundy-Gulf of Maine, because of high benthic diversity. See Figure E.17 for location of this and other sites identified by MCBI. A discussion paper by Fundy Fixed Gear Council (FFGC) (Bull, Pers. Com.) relates the frustration of fishermen with the lack of conservation measures for the area. The FFGC proposed a limit to the mobile fleet in order to protect the area near Long Island and Brier Island.

Trinity and Lurcher

Stephenson et al. (1999) documented large numbers of spawning herring in Trinity and Lurcher Ledges, although the levels remain below the early 1980's. Other current spawning areas included North of Grand Manan, and Cape Chignecto (Figure E.5). Das (1968) recognized herring spawning areas as estimated from newly hatched larval distributions. The main summer-fall spawning occurs south of the mouth of St. Mary's Bay, in the Trinity Ledge-Lurcher Shoals areas, and the larvae are carried into the bay by surface currents. Fishermen report ripe and running adult herring congregating in Lurcher Shoals and Trinity Ledge during late summer. Das (1968) believe that the presence of the larvae in St. Mary's Bay is not due to spawning activity in the bay itself, rather the larvae are transported from the nearby spawning grounds on Trinity Ledge and Lurcher Shoals. Other spawning areas in Bay of Fundy are not as extensive.

The area from Brier Island to Trinity Ledge and Lurcher Shoals are also considered spawning areas for pollock as inferred from icthyoplankton distribution (Mayo et al., 1989). Coon (1998) summarized spawning areas in a map depicting herring, cod, pollock and lobster spawning areas (Figure E.4). Areas noted include Lurcher Shoals and Trinity Ledge.

E - MISCELLANEOUS AREAS

AREAS OF FINFISH SPAWNING AND DIVERSITY

Overviews specific to spawning areas found in the literature include the most recent by Graham et al. (2002), which summarizes spawning information for groundfish species from the literature as well as knowledge documented from fishermen. Their report illustrated both active spawning areas, as well as lost or no longer active areas. Local knowledge is gathered through years of experience, and has been used to identify local stocks, spawning aggregations and nursery areas, and more recently to identify potential protected areas. Fishermen indicated that many coastal areas had evidence of finfish spawning (cod, haddock and pollock) in the past, including coastal Nova Scotia from Scots Bay to Lurcher Shoal, coastal New Brunswick from Passamaquoddy Bay to the mouth of Chignecto Bay, and southeast Grand Manan (The Gravelly). In most cases, these coastal areas are no longer active. Herring spawning grounds are associated with strong currents and mixing. Substrate type is typically pebbly, rocky or gravely, and the eggs adhere to vegetation and substrate (Das 1968). Historical accounts suggest that Scots Bay and the area near Machias Seal Island were spawning sites for herring, and that at present they are no longer active (Stephenson et al., 1999; Coon, 1998). Areas that do remain active (post-1995), and those that fishermen associate with herring spawning, include Southeast Grand Manan, the Shipping lane between Grand Manan and Brier Island, and The Rip. Stephenson et al. (1999) and Das (1968) recognized Trinity Ledge and Lurcher Shoals as herring spawning areas.

Scott (1983) inferred spawning locations in Bay of Fundy and Gulf of Maine for several groundfish (Figure E.2 and E.3). Fish were sampled during the 1970-81 research surveys, and females in the ripe or spawning stages were identified. While cod spawning occurs in a spatially dispersed manner (O'Boyle et all, 1984), inferences could still be made regarding spawning aggregations. Only minor occurrences were found in the Bay of Fundy during the month of March. This information suggests that the areas previously reported by MacKenzie (1934), in Passamaquoddy Bay and along the New Brunswick shore (Figure E.1), are no longer active. Local knowledge from experienced fishermen (Graham et al., 2002) supports this assumption. Graham's information shows that cod spawning areas along the New Brunswick coast, the Quoddy region, and the Digby to Brier Island coastline, all disappeared by 1995. Fishermen's knowledge also suggests that haddock spawning areas have similarly been contracted to just a small area near Old Proprietor Shoal, southeast of Grand Manan, and along Brier Island, from expansive spawning areas prior to 1970 which had included Passamaquoddy Bay and the Quoddy Region, southeast Grand Manan, and the Nova Scotia coast from Minas Channel to Brier Island.

Coastal Spawning and Juvenile areas

While many coastal spawning areas have been lost, the importance of **coastal areas** to the life cycles of many fish is still being demonstrated. Distribution studies (Hanke et al.,

2000) for the various stages of cod eggs show that, areas of cod spawning in the Bay of Fundy and Scotian Shelf include coastal zones along the Nova Scotia coast, above Digby Gut (Figure E.7). Juvenile cod have been reported in Passamaquoddy Bay, and during one study were captured in beach seines (MacDonald et al., 1984). Keats et al. (1987) found that in inshore waters off eastern Newfoundland, 1 and 2 year old juvenile cod were associated with communities of macroalgae. In that study, divers making in situ studies observed that *Desmarestia*, a fleshy macroalgae, is used as refuge from predators. When disturbed or chased, the small cod swim down into the algae. Stomach analysis of these juveniles showed that food items included cunner *Tautogolabrus* eggs. Local knowledge as well as video observations, suggest that in the coastal areas of the Quoddy Region, specifically the hardbottom habitat found in the West Isles area (refer to Figure D.2.1), large numbers of juvenile cod are associated with the species complex areas where *Boltemia ovifera* is found (M-I. Buzeta, videolog, 2001). Cunner is also found in these same areas. During an inner Bay of Fundy survey, Daborn and Gregory (1983) found evidence of spawning of lumpfish *Cyclopterus lumpus*, in the shallow waters along the Nova Scotia shore (Figure E.8). Spawning occurs in shallow water on rocky substrates. Males remain to guard the nests for 6-8 weeks until the young hatch, while females presumably swim out into deeper water. Spawning of lumpfish has been recorded and photographed in the West Isles and The Wolves Islands (refer to Section D.2, Quoddy Region), including the sighting of a spent female in a nearby crevice. Large numbers of small individuals are seen in late summer, attached to rockweed or weirs.

An unpublished discussion document by the Bay of Fundy Fixed Gear Council (FFGC) (Bull, per. com., 2000) specifically addresses the significance of spawning areas to the fishing community. The concern is that the bottom habitat in these areas is being damaged. Suggestions for protection ranged from limiting dragging in these areas, especially the inshore grounds, to establishing Marine Protected Areas. One recommendation was for the FFGC to do what it could to get some of these areas protected. Fishermen feel that spawning areas such as Trinity should be considered for special protection. Willison et al., (1997) suggest the protection of spawning areas for local stocks, such as Trinity Ledge and Scots Bay.

Finfish Biodiversity

Strong and Hanke (1995) found 46 finfish species during summer months along the southwest coast of New Brunswick, and diversity was well above the average (Figure E.9). Diversity was highest in the fall, when 88% of the species occurred. The outer Bay of Fundy, along the northwest shore of Nova Scotia, was the highest reported by Strong and Hanke (1995), with the mean number of species per tow at 14, and a total of 42 in summer. 74% of these species were classified as long-term residents, this community being very stable and diverse. The area between Digby Neck and Grand Manan was also found to be stable (65% long term summer residents) and diverse, with a slightly lower number of species (40).

MUSSEL REEFS OR BIOHERMS

Structurally complex horse mussel beds (*Modiolus modiolus*) in Gulf of Maine are thought to provide refuge from predation (Whitman, 1985), and are considered to be important ecological features because of their role in pelagic-benthic coupling (Wildish and Fader, 1998). Substrate, phytoplankton, and water movements, converge at these bivalve reefs, making these areas highly productive (Wildish and Fader, 1998). Fader points out that the sediments associated with high biomass or production of horse mussels, occur in areas where water is well mixed. Using geological techniques and videograbs, Wildish and Fader (1998) sampled the upper Bay of Fundy and found that horse mussel distribution was limited to the harder more stable substrates, such as gravel, cobble and mottled sand. As well, they found formations of parallel ripples of sand, many with raised features (bioherms), up to 3m high, formed by horse mussels. Mussel reefs (Figure E.9 for locations) are therefore not only found on hard substrate, but also on these bioherms. Areas of gravel and cobble were found to contain a good epifaunal community of sponges, the bryozoan *Flustra*, hydroids and tubed-polychaete worms. Mussels were most abundant in areas of mottled gravel. Sand with bioherms had areas with dense epifaunal communities of sponges, and hydroids such as *Sertularia*.

Modiolus has been found to be a species sensitive to bottom fishing disturbance. MacDonald et al. (1996) and Collie et al. (2000) found it was always absent from disturbed areas, but was found in undisturbed sites. In a study of fauna associated with scallop drags Fuller et al. (1998) reported that horse mussels were found in several areas off Brier Island, and was most abundant in areas above Digby Gut. Dense hydroid communities were associated with the horse mussels, which alter the bottom profile and provide habitat for other species.

G. Fader (per. com., e-mail, 2001) points out that detailed biological sampling is not always available for areas where multibeam information has been obtained. However, based on the information available, the mussel bed areas of the Bay of Fundy should be protected.

AREAS OF IMPORTANCE TO BIRDS

Maps (Figures E.11-14) in this section have been referred earlier as part of area specific information, or by participants of the various Significant[1] Marine and Coastal Areas Workshops (Appendix H). Areas consistently identified in the literature and by workshop participants are:

- Grand Manan, as important to seabirds, shorebirds and waterfowl (Brant, Common Eider), and Brier Island specifically as important to puffins;
- Quoddy Region, important to Bonaparte's Gulls, Common and Arctic Terns, Northern (Red-necked) Phalaropes, and Black Duck, Brant and Common Eider;
- Shepody Bay and Cumberland Basin, important staging area for sandpipers and plovers, and Canada Geese;

- Copequid Bay, for Canada Goose, Black Duck, sandpipers and plovers, and herons; and,
- Brier Island, for Greater and Sooty Shearwaters and Brant.

AREAS PROPOSED IN OTHER STUDIES

i. Table of Proposed Ecological Reserves - New Brunswick Fundy Coastal Zone (Wein and Jones, 1975). Figure E.15.

Location	Feature
Reserve # 5: Little Salmon River Gorge	Steep river gorge, geological formations, productive estuary
Reserve # 16: Campobello's Liberty Point	Rugged rocky terrain, wind-dominated climax vegetation
Reserve # 20: Hardwood Island	Significant and diverse avian populations
Reserve # 27: Cape Spencer	Steep rocky cliffs, natural forest vegetation
Reserve # 71: Musquash Salt Marsh	Salt marsh ecosystem
Reserve # 72: Machias Seal Island	Bird sanctuary and nesting site

ii. Table of Proposed Ecological Reserves (Hunter and Associates, 1982). Figure E.15.

Location	Feature
St. Croix River Estuary	Excellent feeding and staging area for many species of ducks, geese, shorebirds and gulls
St. Andrews-Chamcook area	Excellent feeding and staging area for many species of ducks, geese, shorebirds and gulls
Letite Passage	Major feeding, breeding and staging area for wide assemblage of marine birds
Point Lepreau	Excellent coastal locations for viewing many different species in large numbers of wintering sea birds
Red Head Marsh	Freshwater marsh and wetland with varied habitat. Rich with waterfowl, shorebirds, marsh birds, animals and fish. Uniquely close to Saint John and, therefore endangered.
Quaco Bay	A major staging ground for many species of waterfowl and shorebirds migration.
Mary's Point	Commonly used by more than 200,000 shorebirds during peak migration.
Tantramar Marshes	Most extensive saltwater marshlands along the Fundy coast. Historical agricultural use since the 17th century.

Location	Feature
Deer Island Archipelago	Area has been proposed as a marine park, with high quality scenic views, excellent representation of marine shore environments and a very high diversity and abundance of marine invertebrates, fish, birds & mammals.
Head Harbour Passage including islands and waters between Deer and Campobello Islands	Major feeding, breeding and staging area for wide assemblage of marine birds. Largest concentration of sea birds in the area.
Castalia Marsh	Interesting coastal geomorphology. Large saltwater marsh with an abundance and diversity of common and rare bird species. Some recreational facilities.
Kent Island	Scientific research station for Bowdoin College of Brunswick, Maine. Outstanding bird and plant life. Largest Herring Gull colony on the Atlantic Coast.

iii. Critical marine habitats (Messieh, 1992).

Group	Species	Critical Area	Critical Period	Justification
Groundfish	Cod	Browns Bank	Feb – Apr	Spawning area
	Haddock	Browns Bank	Mar – May	Spawning
Pelagic	Herring	Quoddy Region	All year	Sardine (1-2 yr herring)
Invertebrates	Lobster	Nearshore embayments	Jun – Sep	Larval phases
	Scallop	NE edge Georges Bank	Sep – Oct	Scallop beds and larvae
	Soft –shelled clam	Coastal zone – soft sandy, muddy areas	Jun – Aug	Period of larval settlement, juvenile stage
Marine Mammals	Right whale	Bay of Fundy, Gulf of Maine, Georges Bank	Aug – Nov	Endangered sp., feeding grounds
Seabirds	Gulls, Red-necked Phalaropes	Outer Passamaquoddy Bay	Late Jul – early Sep	Feeding, upwelling areas, euphausiids, copepods
	Phalaropes, Semipalmated Sandpipers; Black Ducks, waterfowl	Coastal saltmarshes and mudflats of upper Bay of Fundy	Mid Jul – early Sep	Feeding areas, high density of amphipods
	Multi-species seabird colonies	Grand Manan Archipelago	Apr – Sep	Breeding area, NACS

iv. Description of the Gulf of Maine International Ocean Wilderness Marine Protected Area

Protection for this area was initially proposed by Willison, then documented by McGarvey and Willison in 1995, and Judson in 1998. The boundaries of this proposal are shown in FigureE.16. Proponents delineated the protected area along the international Hague line (IJC Canada-USA International Boundary), encompassing 5km on each side of the border shared by Canada and the USA, and suggested it would: provide protection of benthic biodiversity, provide a study area, enhance scallop production, and facilitate enforcement along the Canada-USA boundary. A wide diversity of habitats and marine life would be protected, and proponents believe that it would allow for juvenile fish and shellfish to find the nourishment and protective cover they need to survive, thus a steady supply of larval and juvenile fish and shellfish would continually re-seed the Gulf. It would also include old growth northern coral forests living on Georges Bank cliff faces. GOM International Oceans Wilderness proponents suggest it would fulfil the long demanded baseline natural control areas, as marine scientists require such areas to study and understand undersea habitats and their restoration (McGarvey and Willison, 1994; http://www.atlantisforce.org). In 1992 a questionnaire by Messieh, to which 23 scientists responded, had identified Georges Bank as a critical offshore area due to the diversity of commercial species, and the uniqueness of transient spawning. Herring spawning occurs on the Canadian side of the northeastern edge of Georges Bank in September, and cod and haddock spawn near the peak February to April. The northeast edge of Georges Bank was identified as a Critical Area for scallop larvae during September to October. The proposal would also include areas identified by the Marine Conservation Biology Institute as being of high priority for conservation (http://www.mcbi.org, 1999).

v. Table of Benthic Priority Sites in the Gulf of Maine

In 1999 twenty one Canadian and USA scientists were convened by the Marine Conservation Biology Institute (MCBI), a scientific and conservation organization, to identify the "highest priority areas for protection" in the Gulf of Maine. This was done for benthic and pelagic sites, and Figure E.17 shows the locations for the benthic sites identified in Canadian waters extracted from the complete list. Below is the table of criteria for choosing areas for the Benthic Priority Sites in the Gulf of Maine. Complete information is available at the MCBI website (http://www.mcbi.org, 1999).

Number	Criteria
1	Hard bottom, high diversity of sessile marine invertebrates
2	Same as 1
3	Important habitat structure for juvenile fishes, including cod
4	Same as 3
5	Same as 1
6	Soft bottom, "incredibly productive faunal assemblages"
7	Same as 6
8	Hard bottom, Same as 6
9	Soft bottom, Same as 6
10	Critical fish habitat

11	Soft bottom, high invertebrate diversity including sea pens and rare sponges
12	Soft bottom, Same as 6
13	Barndoor skate residual population based on NMFS trawl survey data
14	Hard bottom, Same as 1
15	Canadian MPA closure, high benthic diversity
16	Canadian MPA closure, high benthic diversity
17	Canadian MPA closure, high benthic diversity
18	Important fish nursery habitat, currently a closed area
19	Canadian MPA closure, "old growth" scallop beds, complex bottom habitat
20	Barndoor skate residual population
21	Canadian MPA closure, high biodiversity
22	Soft bottom high diversity
23	Barndoor skate residual population
24	Habitat for cod and one of 2 most important herring eggbeds (seasonal) on Georges Bank
25	Largely undisturbed gravel, rich benthic habitat (i.e. bryozoans and hydrozoans) important to juvenile cod
26	Deep coldwater corals (trees)
27	Barndoor skate residual population
28	Critical fish habitat
29	Corals
30	Soft bottom, high benthic diversity and unique polychaetes
31	Same as 30
32	Canyons with corals and upwellings critical to marine mammals and seabirds
33	Same as 32
34	Barndoor skate, residual populations
35	Critical fish habitat
36	Soft bottom high benthic diversity

F - SUMMARY INFORMATION ON SITES REVIEWED

Criteria used to select areas for management or protection are often grouped into ecological, social, economic or pragmatic reasons. In this document, we primarily summarized ecological information associated with their ecological importance, ecological sensitivity, ecological significance, biodiversity, productivity, or uniqueness. The criteria used to summarize their significance[1] in Table F.1 included those used for the selection of Marine Protected Areas (Canada's *Oceans Act*) and those used for protecting and managing marine resources (International Union for the Conservation of Nature [IUCN], 1988). Additional ecological criteria for selecting marine protected areas could include those further described by Gubbay (1995), such as diversity or richness of habitats and communities not just species diversity, and naturalness or the lack of disturbance or degradation. Vulnerability, as related to coastal or marine developments with large potential impacts, or the evidence of existing and increasing impacts, was not assessed for the majority of the areas reviewed, although some evidence was obtained during the workshops (Appendix H). Many of the areas reviewed had direct references to suggest their sensitivity to disturbance, their ecological importance, their species-specific importance, their high biodiversity, or the reference specifically called for its protection. However, in most cases there was no direct evidence from the literature, or from local knowledge, to make an assessment for all criteria.

Table F1 summarizes this information, along with the checklist of criteria associate with the significance[1] of each site reviewed. The following sites are notable in that there was information to suggest they exhibited at least six, or all seven, of the criteria:

- Brier Island
- West Isles
- The Passages

GENERAL OBSERVATIONS AND RECOMMENDATIONS

Mapping of the sea floor habitat is considered the fundamental first step necessary for oceans management, for monitoring environmental change, and for assessing impact of anthropogenic disturbance on benthic organisms. It is substrate that primarily determines the presence/absence of a particular benthic species (Kostylev et al, 2001). A sea floor habitat mapping study using a combination of geological information and photographic methods to identify commonness of benthic megafauna, identified six main habitat types on Browns Bank, southwestern Scotian Shelf, and east of Gulf of Maine. This type of sea mapping, done at various spatial scales, is needed for the management of the Bay of Fundy. These studies are however very costly and time consuming, and in view of the lack of targeted studies, the authors hope that the information summarized in this document can assist in formulating plans for coastal management in the Bay of Fundy.

Because of the complex bathymetry in some areas of the Bay of Fundy, such as southwestern New Brunswick, the circulation and flushing patterns vary on small space and time scales. This makes it difficult and sometimes inappropriate to make or apply generalizations. Therefore a better understanding of the circulation and mixing dynamics is also needed for addressing coastal zone management issues, including that of nutrification and eutrophication (Page, 2000, unpublished).

Bringing together available literature can provide the necessary information for decisions on oceans management (Hiscock, 1997). Often this information is only adequate at best. Hiscock gives a specific example related to fulfilling the requirements of signatories to the Rio Convention on Biodiversity, 1992: it is proving very difficult to identify marine species of concern, or their priority habitats, partly because this requires information on the rarity of the species, or its decrease in abundance. This review points to some areas being "literature rich," with broad summary descriptions useful in ascertaining the sensitivity, diversity or ecological significance. This is not to say that other sites may not show these attributes if action is taken to obtain the information. The information reviewed points to some areas specifically being highlighted in the literature for their ecological significance. For example, the Quoddy region, and a subset of this, the West Isles, is such an area. While it is described as highly productive and biodiverse, it also has a history of economic development and diversification. This area would greatly benefit by a long-term management plan that integrates the requirements of commercial fisheries and aquaculture, ecotourism, educational, monitoring and research needs, and recreational and riparian activities. Hicklin (2001, Appendix H) recommended that certain mudflats and salt marsh should be protected, as generally their ecological significance is well documented. Many of the sites summarized here are already threatened by increasing use and exploitation and require immediate management, while other sites have been identified as candidates for various types of protection, over and over again, throughout the years. Ardron et al. (2001), in their analysis for designing a Marine Protected Area network in the Central Coast of British Columbia, found that there were recurring areas identified, representing significant "hotspots" for marine conservation, and that these would be necessary in any Marine Protected Areas network solution.

From a general ecological perspective, marshes, estuaries, such as Musquash, and coastal areas, are critical areas to juvenile stages, to spawning, and seabird migration. Concerns for these areas are due to their accessibility, and include degradation by urban and industrial pollution, pesticides, dredging, siltation, and aggregate extraction along gravel beaches. Eutrophication of these areas may result from increase use of fertilizers or nutrient loading, leading to increased particulate matter and algal blooms. Coastal waters are viewed as a convenient area for disposal or for development, but nearshore embayments are identified as critical for larval and juvenile stages of many species, such as lobster larval phases (Messich, 1992), and tidal mudflats (for example Mary's Point) in the upper Bay of Fundy.

Thomas (2001, Appendix H) suggests that un-impacted areas should have priority in protection, rather than just sensitive areas. The areas that are most likely to be impacted are those in the shallow coastal zone, where most human activities occur (Hiscock, 1997). There is also concern with the spread of fishing effort to areas previously avoided (Collie et al, 2000). Bosien's (2001) concern is that these activities may be destroying this diverse invertebrate habitat. A study on the Northern edge of Georges Bank found that disturbed benthic sites lacked epifaunal taxa, any colonial species, non-burrowing anemones, shrimps, sponges, nudibranchs, small fish, and some tube worms. Structurally complex benthic habitats tend to be more sensitive to fishing disturbance (Auster et al., 1996), and bottom disruption removes epifauna, reducing the habitat complexity that harbours small fish, reducing diversity and productivity.

Usually the greatest abundance of life is found within easy reach of coastal communities, and is therefore under constant threat from everyday activities (Clark, 1977). There are many concerns regarding the increasing and cumulative pressures from coastal activities, aquaculture, rockweed harvesting, periwinkle harvesting, coastal dragging and general coastal development. Included here would also be ecotourism, as Blinn (2001, Appendix H) suggests that kayaking has brought visitors to remote coastal and island locations not previously disturbed by visitors, thus affecting bird nesting. Increased boating activities, industrial activities causing noise pollution, and activities causing habitat and behavioural disturbance, all have an impact. Additionally, the cumulative effect of industrial and household effluents, increased organic load, and the increase in use of chemical therapeutics, is yet to be quantified. Diamond (2001, Appendix H) states that we need more information on the cumulative impact caused by the increasing number of visitors and industries, and that these issues should be addressed under integrated coastal management. Clark (1977) recommends that an inventory of "vital" areas should be done as an early step towards coastal management. These vital areas include areas vital as habitat, productive areas, and areas providing structural integrity to the ecosystem. Included here are coral reefs, rock outcrops, marshes, kelp beds, spawning, rearing, and wintering areas. Clark states that we should expect major damage to coastal ecosystems, and a severe decrease of carrying capacity, if there is a significant loss or deterioration of vital areas. Whether described as vital areas or significant[1] areas as described here, the list of *generic* habitat types reviewed is much the same: marshes, mudflats, spawning and aggregation areas, rearing and juvenile areas, reefs/rock outcrops, deep channels, and physically complex areas with high biodiversity. These areas may show evidence of biodiversity, as represented by "species richness," or contribute to maintenance of genetic diversity (ex. spawning sites). As well, to protect "biodiversity" (Roff and Day, 2000) we may have to protect representative areas, not just unique areas. Therefore, protecting areas containing a range of habitats, within a small geographic area would maximize protection of both species and genetic diversity (Jones, 2002).

NEXT STEPS

From an ecological perspective, in order to prepare for coastal or marine management initiatives, we need to:

- Predict where habitat types might be, often with very little available information, in order to make decisions.

- Identify which sites might require specific conservation/protection measures, those that are representative of the various habitat types found, and those habitat types that are rarely seen, and are therefore rare or unique, as well as areas of high biodiversity.

For a scientifically based evaluation of an area's sensitivity to development, or for its ecological significance, Roff and Day (2000) suggest that a classification system is required. This system would identify which areas are representative, where and how many, and which are distinctive/unique and at what scale. To summarize areas as either distinctive of representative, there is a requirement to be able to predict where certain habitat types occur, while using the minimum information that might be available. Zacharias and Roff (2001) state that that it would be invaluable to marine conservation efforts, to be able to predict habitat types and community composition from a few observable "habitat indicator" species. The use of species as habitat indicators is considered "intuitive" and is generally accepted (Zacharias and Roff, 2001). Conservation of representative examples of major habitat types within a region is accepted as the classical approach towards conservation; by preserving representative ecosystems, Jones (2002) suggests the species present in each habitat type are likely to be preserved, as are their genetic diversity. Marine Protected Area designation under Canada's *Oceans Act* does not include representative areas, rather it focuses on unique areas. However, such a classification system would assist DFO in selection of distinctive, or unique, habitats for protection, and help design a system of marine protected areas.

While Roff and Day (2000) stress that there needs to be a systematic and science-based approach, they also point out that such a method would not necessarily include all the unique and special marine features that should or need to be protected. They explain that these areas can be identified separately and designed to contribute towards the overall system, even if their contributions are analyzed in hindsight. Support for this dual methodology is found in several public discussions (Buzeta, in Chopin and Wells, 2000).

Inshore areas have a growing intensity of multiple uses, often overlapping within a very small geographic area, and most often with no identified management objectives or framework to implement any such management. For the most part, the sea is viewed in relation to its resources, with little intrinsic value attached. Adverse effects are not easily apparent or of concern, until these resources are threatened (Jones, 2002). The type of management and protection that a representative or a distinctive site will require, will therefore depend on more than just their ecological value; coastal communities and coastal and marine industries will need to participate to define their vision for the future of these areas. However, the basic rules highlighted by Clark (1977) (listed in Section A, this report), for environmental management of coastal and marine waters should be remembered, specifically that concerning coastal areas:

> "*The more excessive the coastal and marine development, the higher the need for preserving vital (*significant[1]*) areas.*"

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TABLE F1. QUICK REFERENCE TO INFORMATION FOUND.

Reference to Section in Document	Site name	Endangered / Threatened species	Productive, Resources	Unique / ecologically significant	Spawning/ larval/nursery/ staging area	Biodiverse	Education, research, monitoring	Recommendations for protection found in the literature.	References
D.1	**Grand Manan**								The Grand Manan area is a Natural Area of Canadian Significance (NACS).
D.1	Flagg/Whale Cove		√	√	√		√		Berried female lobster aggregation, science monitoring (Campbell 1990; Lawton 1992, and Traditional Ecological Knowledge). Area 5 km north is a major wintering area for Razorbills (Diamond, 2001)
D.1	Southwest Grand Manan area		√		√		√		Long term monitoring of seaweeds in Long Pond Beach area (Chopin et al, 2001). Kent, Hay, Sheep Islands - Long-standing scientific research and habitat protection by Bowdoin College. Terrestrial habitat critical for seabird nesting and associated waters are important feeding areas for eiders and other seabirds (Blinn, Wheelwright, Christie, Diamond, 2001). Old Proprietor shoals - Major wintering area for Razorbills (Diamond, 2001).
D.1	Machias Seal Island	√				√	√	√	Significant area for puffin and Arctic Tern nesting (Hunter and Associates, 1982; Hicklin and Smith, 1984; Burt 1997; Diamond 2001; Davidson, 2001; Christie 2001). Parks Canada NACS; Federal Migratory Bird Sanctuary; recommended as an ecological reserve (Wein & Jones, 1975); Important Bird Area (IBA website); MCBI high priority area.
D.1	Right Whale Conservation box	√			√		√	√	Right whale cow and calf aggregations, nursery and feeding area (Brylinsky et al 1996; Murrison, 2001 App. H; NFS Report, 1991). Gravelly, SE of Grand Manan, the Bulkhead - North Atlantic right whale cow/calf aggregations. Lobster migration path, sensitive from a lobster production perspective; Whistle Rip area important whale feeding ground (Campbell 1990; Lawton, 2001; Burt 1997, Murrison, pers. com. 2001).
D.2	**Quoddy Region**								The Quoddy area is a Natural Area of Canadian Significance (NACS).
D.2	Passamaquoddy Bay, St. Croix River				√		√	√	St. Croix Estuary proposed as an Ecological Reserve for its land characteristics (Hunter & Associates, 1982). Designated a Canadian Heritage River (1991). St. Croix Estuary Project. Sam Orr's Pond - Significant for the presence of quahaugs (Mortimer and Downer, 1961); Nature Trust Preserve; culturally important to The Passamaquoddy People; University study site. High abundance of juvenile lobsters in Birch Cove (Lawton, 1992).

Checkmark symbols (√) denote a reference was found in the scientific or technical literature, or from traditional ecological knowledge.

Reference to Section in Document	Site name	Endangered / Threatened species	Productive, Resources	Unique / ecologically significant	Spawning/ larval/nursery/ staging area	Biodiverse	Education, research, monitoring	Recommendations for protection found in the literature.	References
D.2	West Isles		√	√	√	√	√	√	From the Western Passage along the east coast of Deer Island, to Letite Passage. Critical habitat for young herring (Messieh, 1992). Highest environmental risk area in the eastern Canadian seaboard (Yuen, 1976). Proposed by the International Marine Mammal Association (IMMA) as a marine protected area. Identified as a Natural Area of Canadian Significance (NACS), and proposed as a National Marine Park. Area of high benthic diversity and protection priority (MCBI). Location of university study sites (Chopin, 2001; M. Owen, pers. com.). Significant marine mammal aggregations (Burt, 1997; Gaskin, 1985). Major feeding area for Red-necked Phalaropes and Bonaparte's Gulls (Diamond, 2001). Green's Point - rockweed study site and long term intertidal study site for various universities (Chopin, 2001). Splitting knife and Adams ledges - seal haulouts, tourism (TEK). Significant to marine conservation, highly diverse benthic communities (Lawton, 1992, 1993). Feeding grounds to several eagles. Location of university field studies, tourism and recreation. Barnes/Mowatt/Nubble Is - land protected by Nature Trust. Research/monitoring site for rockweed studies (S. Corrigan, pers. com. 2000). Functional herring weir. Eastern side of Mowatt has several subtidal rocky communities rich in sessile invertebrates, sponges and tunicates, and several species of finfish such as tautogs, cunner, pollock, wolffish and juvenile cod. White island - shallow soft sediment area has *Coryphella/Corymorpha* community, plus geographically rare species, *Edwardsia elegans* (MacKay et al., 1978, TEK). In deeper water, wolffish and sessile filter feeders are present. Productive herring weir. An eagle's nest on the island is routinely visited by kayakers and boat tours. Casco Is, Simpson's Is, Sandy Is, Spruce Is contain rocky substrate and walls that provide habitat to an abundant and diverse community of sessile organisms (MacKay et al., 1979; Lawton, 1993; Thomas, 2000 Pers. com.m). High benthic cover, unique assemblage of organisms: large sponge, soft coral and tunicate communities, anemones, lobsters, juvenile cod, redfish, winter flounder aggregations, eyed skates, lumpfish redds. These diverse rocky communities of filter feeders and associated finfish are not generally distributed through the region and are considered to be significant to marine conservation and should be evaluated (Lawton, 1993). Casco Island has a spectacular underwater wall, strong currents, grottos, high biodiversity, finfish, wolffish, tunicates, anemones, tautogs and redfish (MacKay et al., 1978, M. Owen, 2001). Whalewatching, fishing and handlining area. Site is heavily used by university (UWO) and recreational divers for studies, public education and photography. Sandy Island is used for recreation by community and for tourism; only accessible sandy beach in area; attached weir in operation; seal haulout on ledge; nesting area for eiders and gulls. The range in sediment types and associated species, within a short distance, present a diversity of habitat types and associated fauna that make it an excellent educational/study site. Benthic habitat varies from mud/sand with burrowing anemones, to a rocky wall habitat with a large number of sessile invertebrates, including some geographically rare species such as *Edwardsia and Sclerodactyla*, pollock, tautogs, redfish, wolffish, and lobsters. Spruce Island has a large Great Blue Heron population. Tinker Is - bird nesting and seal haulout area, migratory/movement path of harbour porpoise and minke whales (Gaskin, 1985). Sandy and Tinker island are very close together, linked by a series of rock outcrops.

Checkmark symbols (√) denote a reference was found in the scientific or technical literature, or from traditional ecological knowledge.

Reference to Section in Document	Site name	Endangered / Threatened species	Productive, Resources	Unique / ecologically significant	Spawning/ larval/nursery/ staging area	Biodiverse	Education, research, monitoring	Recommendations for protection found in the literature.	References
D.2	The Passages		√	√	√	√	√	√	Big Letite and Little Letite Passages - Rocky substrate and walls that provide habitat to an abundant and diverse community of sessile organisms (MacKay et al., 1978; Thomas, pers. com. 2000). High benthic cover, unique assemblage of organisms: large sponges, soft coral and tunicate communities, lobsters. The area is considered vulnerable and recent dragging activities and increasing commercial and recreational activities are a potential threat (Thomas, 2001; Bosien, 2001). Ships Harbour on McMaster Island is a safe harbour on the passages, heavily used by recreational boaters and the aquaculture industry. Includes a small salt pond with sticklebacks, mummicogs, eagles, mallards, herons and kingfishers. The island has archeologically important shell middens (Black, pers. com., 2000), and is of spiritual importance to the Passamaquoddy People (Akagi, 2001). Head Harbour Passage - Highly productive upwellings, seabirds, whales, sunfish, groundfish, traditional mackerel fishing and handlining area, and gill netting (TEK, Murrison, pers. com., 2001). There are several productive herring weirs in the area. Increasing commercial and recreational uses may pose a threat (Diamond, 2001). Head Harbour lighthouse being developed as a tourism site. The Passages are considered worthy of protection by Thomas (2001, App H).
D.2	White Horse, The Wolves		√		√		√		White Horse - bird nesting island, and several oceanic birds are sighted in the area: murres, parasitic yaeger. Only breeding site in the Bay of Fundy of Northern Gannet, first nesting in 1990 since 1880 (S. Corrigan, pers. com. 2000); also a large colony of Double-crested Cormorant; newly colonized site of Black-legged Kittiwakes; and possible new breeding site of Atlantic Puffins; CWS study site, feeding areas for birds, terrestrial habitat critical for nesting (Diamond, 2001). Harbour Seal haulout and pupping area, grey seals sighted. Whale and birdwatching area for tourism. The Wolves Islands - farthest of the Quoddy islands, large kelp beds, strong currents. Large variety of finfish herring, pollock, tautogs, lumpfish spawning area, and large diversity of sessile communities typical of strong currents, such as large sponges and tunicates (MacKay et al., 1979). Nearby haddock spawning, and cod and lobster nursery areas (Coon, 1998). CWS has ongoing seabird studies. Major breeding area of Common Eiders, wintering area for Harlequin Ducks, recent recorded breeding areas for Razorbills (Mawhinny & Deaers, 1996). Listed as an Important Bird Area (IBA website). Shallow water immediately inshore used by harlequins in winter and by eiders in summer (Diamond, 2001 App. H). Several active herring weirs, some ecotourism, whalewatching, recreational scuba diving.

Checkmark symbols (√) denote a reference was found in the scientific or technical literature, or from traditional ecological knowledge.

Reference to Section in Document	Site name	Endangered / Threatened species	Productive, Resources	Unique / ecologically significant	Spawning/ larval/nursery/ staging area	Biodiverse	Education, research, monitoring	Recommendations for protection found in the literature.	References
D.2	Maces Bay				√		√		Terrestrial habitat critical for nesting seabirds; associated feeding areas (Diamond, 2001). Salkeld Islands and New River Beach in Pocologan Harbour - important nesting colonies of Common Eiders and important brood-rearing habitats (rockweed beds) along the mainland shore (Diamond, 2001). Ecologically significant, substantial lobster and scallop nursery function supports nearby fisheries (Lawton, 1992; and various Pers. com.). Pocologan Is and French Ledges - high abundance of lobster juveniles and scallop spat (Lawton, 1992). Maces Bay Ledges - long term seaweed study site (Chopin. 2001). Dipper Harbour - principal site of the focused field studies on juvenile lobster ecology, juvenile lobster densities among the highest located in the DFO-ERDA study in 1992 in the Fundy Isles region. (Lawton, 1992 and ongoing).
D.3	**Musquash**		√	√			√	√	Recommended for protection because area is unimpacted, and is considered a productive, fully functioning salt marsh and estuary (Wein & Jones 1975; Brilliant, 2001; CCNB 1996; Thomas, 2001; DFO 2000). High community support for its protection as a Marine protected Area under the Oceans Act; designated by DFO as an Area of Interest. Headland used for research and education by universities.
D.4	**Inner Bay of Fundy**								
D.4	Chignecto Bay	√			√		√	√	Mary's Point, Grindstone Is - Migratory shore birds, mud flats, corophium (Hicklin, 2001). Grindstone Is is recognized as ecologically significant for its Great Blue Heron colony. Mary's Point is under some protection; site used for ecotourism, education, and CWS studies. Proposed as an ecological Reserve (Hunter and Assoc, 1982); designated a Ramsar site and a Western Hemisphere Shorebird Reserve; listed as an Important Bird Area (IBA website); it is also part of the Shepody National Wildlife Area. Recommended for permanent protection (Majka 2001). Chignecto is included as part of the proposed UNESCO Biosphere. Shubenacadie River is a known spawning area for striped bass.
D.4	Minas Basin		√		√		√	√	Minas Basin - Community lead Integrated Management effort is identifying significant habitats. Southern Bight - biologically rich mud flats recommended for legislated protection (Hicklin 2001). Critical and significant habitat to Semipalmated Sandpipers during their southward migration. Spencers Is, Cape d'Or, Southern Blight and Copequid Bay - listed as Important Bird Areas (IBA website). Shubenacadie River - spawning area for striped bass; important wintering area for Bald Eagles. Evangeline area - Parks Canada NACS. Salt marsh and coastal area ecologically significant as shorebird habitat. Nature Conservancy of Canada involved in land protection efforts (Maillett 2001). Boot Is - National Wildlife area has a significant Great Blue Heron population. Ile Haute - Pelagic/benthic coupling; high productivity; salt marsh area, bird nesting island includes eiders and Peregrine Falcon. Identified by CWS for the salt marsh and bird nesting. Identified as an area of "highest priority for protection" (MCBI, 1999). Scots Bay - Herring spawning (Leim 1931, Iles and Sinclair 1982, Stephenson et al 1999).

Checkmark symbols (√) denote a reference was found in the scientific or technical literature, or from traditional ecological knowledge.

Reference to Section in Document	Site name	Endangered / Threatened species	Productive, Resources	Unique / ecologically significant	Spawning/ larval/nursery/ staging area	Biodiverse	Education, research, monitoring	Recommendations for protection found in the literature.	References
D.5	NS Shore and Brier Island	√	√	√	√	√	√	√	Annapolis valley - extensive salt marsh (CCRM, 1999). Brier Island - highly productive area important to seabirds, herring, and cetaceans (Dadswell et al, 1996). Important bird area for shearwaters (Messieh, 1992). Identified as a NACS, and as an area of "highest priority for conservation" (MCBI, 1999). Grand Channel has highly biodiverse shores. Large sponge communities (MacKay, 1977).
E	Fish spawning areas; coastal juvenile areas		√		√			√	Cape St. Mary's, Trinity and Lurcher – recognized herring spawning areas (Stephenson, 1999; Das, 1968). Areas identified as "highest priority for conservation" (MCBI, 1999). Coastal areas for spawning and juvenile cod habitat (MacDonald et al 1984; Keats et al, 1987).
E	Mussel reefs (Bioherms)		√	√				√	Structurally complex areas provide refuge and feeding for associated species including groundfish (Wildish, 1998). Ecologically important in benthic-pelagic coupling (Wildish and Fader, 1998).
E	Migratory bird staging areas	√	√		√		√	√	Areas of importance to bird staging, nesting and juvenile rearing

Checkmark symbols (√) denote a reference was found in the scientific or technical literature, or from traditional ecological knowledge.

Checkmark symbols (√) denote a reference was found in the scientific or technical literature, or from traditional ecological knowledge.

G - REFERENCES

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H - APPENDIX: WORKSHOPS, SUBMISSIONS AND OTHER REFERENCES

All descriptive maps obtained through workshops or written submissions are included in this Appendix, and referred to in the document as Appendix H, 2001.

SIGNIFICANT[1] MARINE AND COASTAL AREAS WORKSHOPS (SAW) - DESCRIPTION

The following was an invitation for fishing organizations, community groups, academic and research institutions, First Nations, non-governmental organizations, scientists or individuals, to participate in identifying significant[1] marine and coastal areas, by holding or participating in a workshop, or by making a written submission. Initially, the workshop used the term "sensitive" rather than "significant" in its title and during discussions. The definition for either term is one and the same, as defined in this document, but it was later felt the term "significant" was more consistent with other similar reports by DFO. Therefore, in this document we refer to the workshop as Identificication of Significant[1] Marine and Coastal Areas, and to the areas identified/discussed, as significant[1].

All workshops began with an introduction to the *Oceans Act*, Marine Protected Areas, and mapping of significant[1] areas.

Introduction: There are many pressures on the Bay of Fundy ecosystem, including coastal development, traditional fishing, new industries such as aquaculture and rockweed harvesting, increased habitat destruction, and increased pollutants. It is essential, therefore, to identify ecologically sensitive marine and coastal areas, areas of high biodiversity, areas of ecological or scientific significance, or of community value (referred to here as significant[1]), and to recommend appropriate management initiatives for these areas. The information gained through this workshop will assist in the development of a Bay of Fundy Ocean and Coastal Management (OCM) plan, as well as assisting in identifying an effective system of Marine Protected Areas (MPAs). Tying all available information together will help identify key areas, management options and appropriate tools.

The identification of any sites as potential MPAs will require site specific consideration and consultation, but may comprise one of several options in formulating a system plan consisting of areas that are of biological and social importance, giving priority to review potentially threatened sites first. Not all sites will fit within a MPA system plan; some will require protection under other conservation legislation. Those that do will be reviewed by applying a set of criteria, along with a review process of ecological information, and through consultation with all interested parties.

Overall objective: To identify significant[1] marine and coastal areas, as defined in this document, in the Bay of Fundy, and to recommend management initiatives.

Methodology: The format for each workshop was determined by each group participating. A facilitator arranged the workshops, facilitated discussions, and assisted in filling out the Site Specific Questionnaire. All workshops were videotaped, and transcripts prepared and edited by participants. Participants were asked to prepare a short presentation or to fill out the questionnaire, and summarize their accumulated knowledge and experience, regarding the ecology, natural history, and fishery of each area. Using charts, each area was identified, and the reasons described. Participants also suggested management options and tools for use in the area described.

SITE SPECIFIC QUESTIONNAIRE SAMPLE

Site Name (Commonly used name or location)

Where: GIS reference: single coordinate, table of points, or GIS referenced image.
Is there an accompanying chart or image (photocopy of chart, printed digital chart, electronic map, or photograph showing location):
Description of location: (landmarks, distance from shore, island, town, fishing grounds)
Approx. parameters (area, depth; describe any known topography or physical features):
Marine structures (weirs, aquaculture sites, wharves; ledges):
Land structures: (coastal dwellings, islands within area depicted)

Why

Critical/significant habitat: (physical and biological description, list of species)
Single species importance: (does it concern a geographically rare, threatened or endangered species, or a commercially threatened species?)
Biological/ecological characteristic: (life cycle stage such as spawning or feeding aggregations, or migratory path)
Biodiversity (is there a list of species or reference to one or estimate of biodiversity):
Visualization (are images or videos available to visualize the significance of the area):
Description: (average depth, currents)
General References/Data available (published or unpublished reference material, data, logbook information, Traditional Ecological Knowledge):
Non-biological or non-ecological factors (does area have any historical, archaeological or cultural significance?):

How

Concerns, threats: (are there potential threats, are these threats being managed at present?)
Are any of these threats cumulative?
Interested parties (Is area used for research, study, harvesting, recreation? Are there other individuals/groups that have interests in this area, either for the resources and/or for its protection):
Is this area already managed under a specific initiative or regulation? (reserve, bird sanctuary, exclusion zone or closure):

Management recommendations: (options, requirements)

SAINT JOHN, NEW BRUNSWICK WORKSHOP (SAW-UNB)

Oland Hall, University of New Brunswick
January 17, 2001

Participants

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Dr. Matthew Litvak, Saint John River System.

There are a number of species of concern in that region. The short-nosed sturgeon is a species of special concern. A second species that will probably eventually join that list is the Atlantic sturgeon, *Acipenser oxyrinchus oxyrhinchus*. It is under consideration for being listed as endangered in the U.S., but is still commercially harvested here. This harvest is terminal, that is, the licences can not be passed on or sold after the fishermen stop using them. Obviously, there are people who are very concerned about Atlantic salmon in the Bay of Fundy and St. John River system. The source of many of the problems in the area is actually Saint John, and all the things that get dumped in the river from there. What is needed is to have groups like ACAP to provide guidelines to prevent further damage. Obviously, dumping raw sewage into the area will have an impact on all the other MPAs down the line.

It's hard to say whether protection for the sturgeon could be achieved through a site-specific approach. Some have been caught outside Saint John Harbour, whereas we've never had any of our tagged fish go below the Reversing Falls. And they've all stayed within the estuary and gone on upriver above Maqtaquac dam. The lovely part about it is that the Short-nosed, which can be much more wide ranging in distribution, are in an area where we can interact with them. In the Atlantic it's more problematic as they are truly anadromous, and they spend only a certain amount of time in the estuary. A lot of the juveniles, from both species, spend a tremendous amount of time in the estuary. When you're talking about a species that can live till 60 years old, that's a lot of time in one place.

There is more targeted fishing of the Atlantic sturgeon here than in the States. And there's argument about whether or not the stocks are separate. There's an argument about whether they should all be listed as endangered, or just listed as endangered in certain areas. In the US they now have a document where they say this is endangered or threatened in certain areas and they decide to focus on those areas to protect these species in those areas.

Threats to sturgeon would include flow rates, management of dams, diversion of water, also possible overfishing, pollution, and specific to our area is a lack of information. What we need in regards to sturgeon is some estimate of population, where they are within the region. We're just starting to get information on habitat, but there is no money for information, so there is no information to justify needing money for further study.

Colin Bates, Seaweed Bio-diversity

(Figure H.1a, b, c, and submissions in Appendix H-iv)

Along with everyone else here, we're concerned with the degree of impact of activities in the Bay of Fundy and the lack of information on seaweed diversity. Based on that we implemented a biomonitoring program at six sites in the Bay. We have a sheltered and an exposed site at Green's Point, near the Letite lighthouse. We have a sheltered site at Lepreau Ledges, and an exposed site at the nearest point, without going on, to Power Plant land. We also have a southeast Grand Manan exposed site, and near Castalia a sheltered site. We go out there three times a year. Our sites are 30 meters wide, running from high water to low water. We run transects and put down quadrats and do basic ecological sampling and look for percent cover of whatever species we find. We also do haphazard site searches to try to get species lists. We also take abiotic information, such as temperature and salinity, nutrients within algal tissue, as well as seawater samples. We just want to get a picture of what is happening at these sites, and we're doing it because seaweeds are economically and ecologically important, but are most often ignored in marine conservation plans, despite being excellent nutrient bioindicators. The UN Convention on Biodiversity doesn't even mention seaweeds. Our monitoring has uncovered a number of problems, two of which I'd like to talk about first.

I have a couple of pictures to pass around of what Letite is looking like, with regards to some of the symptoms I'm talking about. There's a volume that came out about 5 years ago - and I have the reference - called *Marine Benthic Vegetation and the Changes and Effects of Eutrophication* (Schramm & Nienhuis, 1996). It outlines a number of symptoms that we're monitoring for - decreased diversity and abundance of red algae, blooms of short-lived filamentous algae, increased number and density of benthic filter feeders and detritus-feeding organisms such as mussels and sea urchins, the green tide phenomenon and a general impoverishment in the diversity of flora. We examine our sites for these things. I have graphs here. Percent cover of red/green algae: Grand Manan is showing an average of 30% cover, as well as Lepreau, which is our mainland reference site, and Letite (the exposed site, and the sheltered area as well) is showing about half of that. The bottom graph is showing average number of species. Letite is showing a lower number of red algal species than the mainland reference and the Grand Manan site. Second point: blooms of short-lived filamentous algae: we're looking at *Ectocarpus* spp. and *Pilayella littoralis* - they are filamentous brown algae that look like brown fuzz all over the rockweed. Letite sites are showing a higher percent cover of these species. It is a seasonal phenomenon; a spring blooming algae. As for increased benthic filter feeders, like mussels, Letite is showing a lot higher number, and we're also seeing blooms of sea urchins. We're not really seeing anything in the way of green tide at our sites, although it has been seen elsewhere in the Bay of Fundy, most probably because of the type of substrate. The highest percent cover at any site is about 10. Green tides are dependent on the substratum, and you don't see green tides at rocky sites.

We are now using the Shannon diversity index, which isn't bearing out what we'd expect based on the indicator species. It is not dependent on the composition of the flora, just percent cover of the species present, so it reflects qualitative change, not quantitative changes. We are currently looking at other methods of assessing biodiversity. Grand Manan is marginal, but not statistically different. The high biodiversity of species reflected in the high Shannon Index reflects the number of species and the relative evenness of each of the species. Higher diversity would indicate more species that are more evenly distributed.

The last data available for comparison is from 1979, and is a summation of what was available up to that point. It's mostly in the form of presence and absence data. We can't find any transect data or quadrat data to allow us to compare to our current monitoring, which doesn't allow us to say anything about a change in percent cover.

The Grand Manan sheltered site is not as diverse as the exposed site. Sheltered sites are generally less diverse than exposed. It seems that the exposed site at Letite has been degraded to a point where it's similar to our best-sheltered site within Grand Manan. Macroalgae have a number of requirements for success in life, such as substrate to attach to, a clear water column that allows light to penetrate for photosynthesis, and they need to be able to disperse their spores and gametes. Our recommendations stem from an effort to maximize these requirements, by minimizing things like excess nutrient input which contribute to algal blooms, causing increased competition between and within other algal species. Epiphyte loads can cause increased drag such that the host algae can get ripped off the rocks. Secondly, increased siltation can alter light level in the water column, effectively decreasing the photoperiod, which can affect timing of reproduction. Most algae have adapted to a certain photoperiod. Lastly, input of organic particulate matter can act as a food source for mussels and sea urchins, allowing the mussels to compete with the algae for substrate, and to filter out algal spores. The sea urchins also eat seaweeds, which can result in subtidal "pavement" or urchin barrens.

As far as conservation recommendations, the Letite sites are showing symptoms of degradation that is characteristic of western European communities where there is a lot of nutrification happening. Secondly, Grand Manan, which is our most exposed site, is not showing any of these signs. So based on these observations, we'd like to suggest that Letite be considered for restoration, if possible, and Grand Manan considered for protection. It's important to point out that the protection can be spatial, such as a MPA, or temporal (seasonal) - just a reduction in activities that contribute to these conditions - allowing the algae community to recover. The algae would probably recover quite quickly because they're adapted to life in a high disturbance area. One option would be a fallowing for a year, or four years of aquaculture and then a year off to allow organisms to replenish themselves. Grand Manan is suggested because it is further out in the Bay of Fundy, and may serve as a seed bank for coastal regions in the upper and middle coasts of the Bay. More details about monitoring program can be found in the BoFEP workshop proceedings I mentioned (Bates et. al, 2001b), as well as a summary of what I've told you here. This is the volume with the symptoms and a whole lot of information about the effects of anthropogenic pressure on the sea.

What is interesting is that Europe, in terms of eutrophication, has maybe 15-20 years of study ahead of us. They have done experiments on the big scale. The description of the succession of things is remarkable because succession is going on different fronts. There's a lot to learn from ecosystems that have been studied for 15-20 years, but exactly the same processes are occurring here. Ten years ago there were some very rich, beautiful tide pools at Green's Point. Now, they are not as diverse; there are no intertidal pools, and there are sea urchins and mussels covering everything. The only seaweed you see is

Desmarestia, because it contains sulphuric acid as a very efficient grazing deterrent (T. Chopin).

I would question, though, whether a sea urchin bloom caused the change. Urchin aggregations naturally occur in a lot of places. I can think of dozens of places where they encroach, depending on time of year. I am sure a lot of those mussels are coming from net cleaning activities on aquaculture sites (R.Bosien).

There is also Maces Bay Ledges. That site is used for ecophysiology and biochemistry of rockweed. The question with Colin's work is that after it ends what happens? After that, with Gary Saunders, we are interested in very long term monitoring. That is what is missing – very, very long term monitoring. We are interested in continuing the work that Martin Thomas started some time ago.

We are interested in these long-term studies and as Colin mentioned, interdisciplinary studies. Seaweeds can be good bioindicators. What is the function of seaweeds in an ecosystem? For example, if you talk about nutrification in a coastal region, how many times do you put seaweed into the picture? Seaweeds are like a sponge in that they act like nutrient scrubbers. We like to keep some sites as reference sites with as minimal an anthropogenic impact as we can. For rockweed for example, this would mean having a few well-known exclusion zones where there is no harvesting. Musquash Head could be such a site, as the access is not easy (T.Chopin).

What do we mean by high biodiversity? For example, in Brittany, western France, which is a transition zone between cold temperate and warm temperate, you have roughly 800 species of seaweed. We have around 80 species. So what do you conclude? You can't just look at the numbers - higher numbers in one area doesn't mean another area with low numbers is less naturally diverse. The numbers have to be applicable to the location (T.Chopin).

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Robert Bosien, Fundy Isles and the Passages

Inshore Dragging

Sea urchins are not as much of a problem as are sea cucumbers. The area I'm concerned with is the Letite/Mohawk Island area where Dr. Thomas has set up a lot of studies. They're dragging them up for very little gain where there are two or three experimental licenses. Sea cucumbers are relatively immobile; if you knock them off their perch they can't crawl back up and currents drag them away from where they want to be. I think they're very important for filtering the water that goes in and out of Passamaquoddy Bay. The areas they're dragging now are down through Black Rock, Mohawk, and almost all is covered with that hairy mat of horse mussels, which are also being dragged, so they're destroying this habitat had never been touched. There is no reason to fish these areas because they're mostly shallow, and cucumbers are the only things there.

Ecotourism

I have some concerns about ecotourism - for example, whale watching. Something as nice as kayaking - we're seeing effects with sea kayaking. Bird nesting areas can be disturbed, because not everyone who kayaks is aware of nesting seasons, and there's nothing nicer than stopping on a island during the journey. There has been an increase in numbers of recreational boating activity, including seadoos. In the 30+ years I've lived in Deer Island I guess that there are 10 to 20 times as many now. I can't imagine what you can do about that. You see seadoos out at the Wolves now. Basically it comes down to the fact that there are just so many more people out there, either for recreational or fishing purposes. Things have changed since I was a youngster. There was no sea urchin industry then. Right up through the intertidal zone, if you concentrate on one species and ignore everything else, you exacerbate the problem. You talk about species diversity - it's disappearing rapidly.

Kayaking can disturb feeding activity of eiders because they can move right along the shore where the birds feed (B. Blinn).

There has been a study in Newfoundland on nesting sea birds and the effect of different boating activities, and kayaks were found to have much more impact. They're not sure why, a combination of reasons. They're able to approach without any warning, whereas motor boats can be heard coming from a long way away. Birds may not be as used to them. But it's pretty clear that the birds do respond to kayaks more strongly (T. Diamond).

While doing some work with harbour seals - we wanted them on rocks – we witnessed on several occasions where professional tourist boat operators were right up to the rocks, bumping the rocks the seals were on, to drive them into the water. They'll purposely flush them into the water, because it's exciting to see (J.Terhune, N.Benjamin).

On noise pollution and industrialization of the Bay waters -
Those noises you're hearing right now, soon almost every one of those sites out there will have one of those big automatic feeders. When they first started out, hand feeding was the standard, and now they're going toward automatic feeding. What you're seeing today will probably increase ten-fold in five years from now.
Now they are also using "photoperiod" lights. All lit up for nighttime feeding.

One thing that really surprised me last July when we were right in the middle of an area of concentration of aquaculture sites, the level of noise due to cranes and other machinery on a regular basis is very high. Forget about your nice little breakfast along the Bay of Fundy (T. Chopin).

Research has been done on chemical impact, etc., but the simple disturbance factor is huge, and any organism that is sensitive to that is at risk. Can eider ducklings even hear the signals from their mother over the noise? It's a huge cumulative impact and we simply haven't addressed that (T. Diamond).

Dr. Tony Diamond, Important Areas for Area Birds

(Figure H.2, and submissions in Appendix H-iv)

Maces Bay

We've got nine sites in my research group and we've been working on a variety of seabirds and waterfowl for the past six years, and so my suggestions very much reflect the kind of research we've been doing and the way we've been doing it. The first is the area between Maces Bay and Pocologan Harbour, which is one of the areas that Brenda was looking at this year. It contains two important nesting colonies of Common Eiders, the Salkeld Islands is one and New River Island in Pocologan Harbour is another. Each of those probably hosts about 500 pairs of Common Eiders, which is a large number by everybody's standards. Also, the rocky beds along the mainland are important feeding areas for the birds. What we found this spring was that there were a lot of eiders feeding on the sea urchins along the mainland coast. We've been doing a lot of research on eiders for the past six years, and one of the things we've confirmed about eiders is that the condition of the female when she lays her eggs in May is critical to her success. And what we don't know now is what determines those conditions in the spring. The eiders were feeding very hard on the sea urchins once mature and it may be that these are an important resource for them. It may be that there are actual links with the benthic fauna that we haven't identified yet, either, and that's going to be a future research effort. That area then between Maces Bay and Pocologan Harbour is important for eiders both for the breeding islands that it has and bird-rearing habitat and the spring feeding habitat. It may be important at other times of the year, too. The only protected status that I'm aware of is New River Island, a nature reserve currently owned by the Nature Conservancy, and about to be transferred to the Nature Trust of New Brunswick, and that's largely on the basis of it's being an eider colony. And then the New River Provincial Park is adjacent to that. These are the only protected areas right now. Threats are rockweed harvesting, increased recreational activity - we have been told by the Department managers that they never saw kayakers landing there before. So that activity is been increasing at this point. My recommendation simply would be to increase the awareness among the local community of the importance of the area to nesting eiders and to monitor the activities. I don't have specific recommendations beyond that.

I am working on eiders from Musquash to St. Andrews, - their selection of brood rearing habitat and the actual disturbances. I have observation points from rockweed harvested sites and non-harvested sites. I'm looking at disturbance by gulls, also, and whether gull density is a factor. I'll be going to Grand Manan this coming summer. I'm interested in the rockweed harvesting industry, and I have a lot of sites which are being harvested kayakers are landing on New River Island. There were a lot of periwinkle harvesters and ATV's at Maces Bay (B. Blinn).

We have been taking notes of these activities when we go out to our Maces Bay Ledges seaweed study site (T. Chopin).

The Wolves

The islands themselves are five privately owned islands which have several herring weirs around them, and a few cabins, but the main importance is that this a Common Eider breeding site. It's an interesting area in which we've done quite a lot of research. It seems to be a sink for eiders; it is a good place to nest but a bad place for them to raise young, both through predation from Great Black-backed Gulls and through rather limited rockweed resources. The sea floor slopes very steeply, which means there isn't a wide area of rockweed.

These islands should have some protected status in that it's a wintering area for the Harlequin Duck, the eastern population of which is in danger. About 35 individuals winter there every year, so it's important from that aspect. The Wolves were colonized recently by Black-legged Kittiwakes, which makes it the southernmost colony in North America. There is also a handful of Razorbills on South Wolf, which is a new colony in recent years. There are Bald Eagles and cormorants nesting. It's very rich. None of the islands has any protected status. The major threats are the potential of an oil spill in nearby shipping lanes, and there is increasing ecotourism activity, including kayaking. And people are not aware of the impact they would have by visiting the island during critical times for eiders. The current level of fishing is not known to be a threat. Increased awareness among users and monitoring of both the activities by users and boats would be my only recommendations at this point.

White Horse Island

This island is between the Wolves and Deer Island. White Horse has a large colony of cormorants, it has lots of black kittiwakes, and in 1999 the first pair of Northern Gannets to nest in the Bay of Fundy since 1880 managed to get a young big enough to be eaten by Bald Eagles this summer. Most of the kittiwakes from South Wolf have moved to White Horse this past summer, so the major colony is now in White Horse. There are also gannets, kittiwakes, cormorants, both species of large gull, and the island is being prospected by puffins, although there's no good evidence that they're actually nesting. So very likely a new nesting site for puffins. It should have some protected status - it's amazing that an island with that much going on doesn't already.

Cormorants winter down to the New England states or even further south. The cormorants we have in the winter are mostly great cormorants. I don't believe eagles nest on White Horse, but what happens there is they come through on fall migration, so we get lots of young Bald Eagles.

I have a picture of puffins going into a crevice, carrying fish. There were enough people on the boat who saw this, whether the video will actually show it. There was also a gray seal confirmed (M-I. Buzeta).

At a meeting last week in Boston the big issue with cormorants being discussed was the aquaculture industry shooting them, but this is taking place further south in the USA. It's a big problem (T. Chopin).

Head Harbour Passage

This is an area of concern as well, essentially from Western Passage along the east coast of Deer Island to Letite Passage, and the reason for that is the fall migration of Bonaparte's Gulls in the fall and early winter. Phalaropes used to pass through in the fall migration in the hundreds of thousands, but they've not been seen since the mid-80's and we don't know why that is. Bonaparte's Gulls, which come through at the same time, and also later, are still passing through the area. It's probably 1/4 to 1/3 of the eastern Canadian Arctic breeding population that pass through this area. They use the Passage as a staging ground and a feeding area during the fall migration, which is when they moult, and that's very unusual, too. That's been a consistent pattern for 25 years at least.

Islands in Passamaquoddy Bay

There are important places in Passamaquoddy Bay, such as Hardwood Island, which has been a large and important Common Eider-nesting colony for many years. It was abandoned a few years ago briefly when a mink got on, but apparently they're back.

Other ones in Passamaquoddy Bay that are of bird interest are Hospital Island, where there's a big colony of Great Black-backed and Herring Gulls – it's interesting from a cultural, historical and archaeological aspect as well. Dick's Island is an eider colony, and has a cormorant colony, too, and that is likely to be acquired by the Nature Trust. There's an aquaculture site right next to it that causes disturbance. Hog Island has an eider colony.

Grand Manan

Going from Long Island round the south and east, including White Head, including the three islands - Kent, Head and Sheep -and across to western Green Island. Most of the islands in there are nesting areas for eiders and other seabirds. The whole area is heavily used as a feeding area by a variety of seabirds throughout the year. This is why I was asking questions about scaling. This whole area is so important that I felt it justified consideration, rather than picking one island here and another there and the sea around each. There is a lot of shallow water, a lot of shallow rockweed, and a lot of eider breeding areas, and we believe this is the only population of Common Eiders in SWNB that isn't a sink. It actually produces enough young to replace itself. The others are all sinks, as far as we know.

As much as 80% of eider recruitment comes from Grand Manan (B. Blinn).

Right Whale Conservation Box (SE Grand Manan)

The areas described in the Right Whale Recovery Plan is a critical summering area for Antarctic seabirds as well. Wilson's Storm-Petrel and Greater and Sooty Shearwaters are there in the thousands and tens of thousands at various times throughout the summer, in the same times and places as the North Atlantic right whales.

Kent Island

The major colony of eiders is on Kent Island, which has de facto protection, as far as legal protection, by being a research site for Bowdoin College. It's protected while they're there, but they're not there very much. They didn't even know it was being harvested for gull eggs. So it's fine when they're there, but the protection is non-existent when they're not. It is a rockweed exclusion area, and there's been a lot of research on a variety of things. Got a very good track record.

Machias Seal Island

This island has the status of a migratory bird sanctuary, under the migratory birds act, only administered by Coast Guard, the conservation management is by Canadian Wildlife Service of Environment Canada. We do research there, and have done since 1995. It's the largest colony of Razorbills in the region, and the largest south of the north shore of the Gulf of St. Lawrence.

It also has the largest colony of Arctic Terns in North America, and it's important for Atlantic Puffins and Common Terns and Common Eiders. We know a great deal about what happens on the island, but we don't know much about what goes on around it. I don't know much about the benthic ecology around the island. We see a lot of sea birds feeding within 5 kilometers of the island. We don't see them feeding farther away, because they're too far for us to see. So we don't know what proportion of the food which is essential is gathered in that 5 km zone. That's a big unknown at this point. Machias Seal Island has proposed 5 km. That will encompass a certain proportion of the usual feeding grounds, but what proportion and for what species I don't know until we've done radio tracking of the species in the area.

There is ecotourism happening there, whether tightly regulated or not. We don't feel it's a danger. We've done a couple of honours studies on that and haven't found anything. There's a lot of fishing activity around there, lobstering and scallop dragging and urchin dragging and I don't know what else. It's the site of a jurisdictional dispute - it's right on the border between U.S. and Canada. Most of the boats there are from the U.S. There have been battles in the past over fishing rights, so it would be tough to get that as a marine protected area, but I think it's worth shooting for. I can't really say if there's increased fishing activity, just a lot of boats. I think from the wildlife conservation side, you will get support from the U.S. Because of the jurisdictional dispute it has a manned lighthouse and that is going to continue.

Old Proprietor's Shoals to the southeast of Grand Manan and the north end of Grand Manan

We have recently discovered that they're a major wintering area for Razorbills, which is a northern nesting seabird, most of which nest off Labrador and the Gulf of St. Lawrence. We have found enough wintering in that area to think birds from all the major North American colonies must be spending at least part of the winter there. We're trying to work out what the patterns of movement are, and it's very difficult. They're very difficult to count, and we're trying to work out why the numbers are so variable. The more information we get, the better we'll understand. Sometimes in winter there are at least 50,000 Razorbills there, of a total estimated North American breeding population of 40,000 pairs. Off Proprietor Shoals there is one concentration, and we see them feeding off Northern Head of Grand Manan. They travel between the two areas round both sides of the island roughly following the 50-fathom contour. In addition, there are whole shallow water areas to the southeast of Grand Manan that may be important in the winter for feeding, but we've highlighted these.

There is a website for the *Important Bird Areas* program that shows maps. It's quite well documented. http://www.bsc-eoc.org/iba/regional.cfm?region=MAR&lang=en
In all these areas (islands) which are important for nesting sea birds, what we don't know is the pattern of use of the surrounding marine area. We don't know how far around they feed and what are the critical areas. At this point, I would simply draw attention to the lack of knowledge and say that we should have a marine buffer zone around these areas with the radius to be discussed.

The subtidal area around Old Proprietor's Shoal is beautiful (B.Bosien).

Dr. Stephen Turnbull, Elasmobranchs (sharks)

Elasmobranchs are pretty wide ranging out there, so there isn't a particular area. We have one of the largest members of that group, the basking shark, here in the Bay. That's receiving protected status in various parts of the world, particularly England and Scotland, and they're pushing to have it protected in Canadian waters, also. There doesn't seem to be a lot of concern about the shark in this area - each year there are several that periodically wash up on the beaches from unknown causes or entanglement. White sharks are protected in Australia, and they are found up here, but they're usually killed. It's really disconcerting. It is difficult to get some information from the fishermen about incidents of capture, fishing weirs or even if they hook them accidentally. Smaller elasmobranchs that were seen in many areas in the past haven't been seen in recent years, so something is going on out there. Not much emphasis is being put on them because they're not commercially important, but they are part of the whole ecosystem. As for the basking sharks in general, the areas where they concentrate in heavy numbers are the same as those where the North Atlantic right whales are found in the summertime. We're just beginning to get a handle on the numbers here in the Bay and are just getting a better idea of where they are and how long they stay here. Right now, the only data I have is all collected secondarily to whales.

There are surveys of the North Atlantic right whale along the entire coast, so there'd be some good information there. The area is very, very important to these sharks. And they're not just found in our waters, they're going up and down coastlines, and there is a big push to have them protected in other countries. The U.S. is pushing for protection of the dogfish shark, which around here is considered a nuisance and a scavenger. They're being considered for listing as endangered there because their numbers are crashing.

There are a lot of sharks caught while fishing and so on. There are an awful lot of juveniles caught in the summertime. Three and four-foot Mako sharks and Sandtiger sharks. Sandtigers are not known to be up in this area at all and are actually found more around the Carolinas. Someone found one off the coast of Barnes Island, and it was only 3.5 feet long and caught in a fishing weir. An awful lot of juvenile Makos get caught in fishing weirs. I'm not sure if this area is a very important area in the summertime for that age class, or what is going on. These things have to be investigated. They're out there, they're an important part of the ecosystem, but very rarely are considered in any type of biodiversity project, because they're considered "just a scavenger," or just not important commercially.

The basking shark, the white shark, even the dogfish shark are all being looked at for protection in other countries. The dogfish are fished like crazy in the Carolinas. The size of the average dogfish caught now is much lower than it used to be. Makos used to be caught at 1100 pounds, commonly; now they're lucky to reach 400 pounds. If we have a lot of juveniles up here in the summertime, this would be a very important feeding ground for those younger fish, if not the big ones that feed on them.

I would like to get a survey out there to get a sense of where they aggregate. Basking sharks are sighted more often because a lot of people are out looking for North Atlantic right whales. They're found in a lot more areas, but people aren't really sure how to identify them, so that's another problem. Last summer, a sailboat was in collision with a "large object" and initially they said it was a basking shark because it was coated with black slime that's a telltale sign. There are a lot more encounters by tuna and longline fishermen than we know about, and these animals are more important out there than people realize. They should be considered in any area, and they should do a survey.

Fishermen could collect information and measure, retain the jaw, etc. That could be something brought up at meetings with fishing associations, for a lot of key species. It seems that certain weirs have a higher number of encounters, so it suggests some kind of pattern of movement, distribution within a certain area. For example, there's a weir out near the Wolves that seems to constantly have something in it.

A shark was caught in a weir off south Wolf (N.Benjamin).

A North Atlantic right whale was sighted in Letite last year (B.Bosien).

Dr. Jack Terhune, Seals and Whales

Regarding seals, the average flushing (when they are disturbed and enter the water) distance from a fishing boat is about 100 meters, and less late in the summer when more and more boats are coming by. Kayaks are particularly disturbing - seals tend to react to kayaks at a greater range, maybe because of the paddle. It's a visual disturbance - movement, flashing, less recognizable, even though they're quiet. The impression that I have over the last 20-some years in the Bay is that the seals are moving around a little bit more, and although there's an assumption that there are a great many more based on anecdotal information, the counts are only a little bit higher. We were receiving counts of about 200 seals in the St. John Harbour last spring. We've had a student counting them the last two summers, and she got a high count of 37 and 55, and that was during the shad/gaspereaux run, and then it dropped right off. There is a lot of variation in counts because they move up and down the coast. For example, on occasion at Pocologan you can get a count of 120, but most of the time there are very few, sometimes zero. So it gives an overall impression that there's more abundance than there is. We conducted aerial surveys in '84, '87 and '98 from Saint John down to Maine, except for the Wolves and Grand Manan, and numbers that hauled out in the afternoons at low tide were essentially the same in all those years. About two-thirds of them leave the area between September and December, and that pattern hasn't changed since '84 or '87. We ran surveys every two weeks in the fall of '98.

Seals are seen as a major problem to two fishing groups, and of course, shooting harbour seals is illegal. There are licenses only for gray seals, and the kill has to be reported. No industry wants to be accused of shooting seals; on the west coast they're reporting kills of about 250 a year of gray and harbour seals, and that's causing some grief.

Long-term studies are tricky to fund, that is why there little information on whether they have changed their haul-out distribution. Tour operators and fishermen could keep records of sightings, and this would be useful particularly if it's done over a number of years. I can think of one study that involved ships going on a regular basis from Australia to Antarctica, and they did a bird watch every hour. So thousands and thousands of observations of latitudes, weather conditions, the whole bit. There is information on haul-outs, where seals were actually observed, but it needs to be converted into a database.

Another concern might be noise pollution - it's technically possible to do a major noise-output study at aquaculture sites, but describing an impact of that is going to be extremely difficult, unless you get animals vacating an area, and then you turn the noise off and they come back, as a control. The amount of work, time and effort would be tremendous. As an example, a grad recently wanted to record underwater noise levels over ten days, and we ended up with five for all the practical reasons in the world.

It's not just seals that are being shot out there, there are a variety of things. There were three blue herons that were just totally blown away. Three in one small area of an island, washed up on shore (S.Turnbull).

Dr. Martin Thomas, Quoddy Passages and Musquash

(Figure H.3a and b, and submissions in Appendix H-iv)

I worked on mostly shallow water and intertidal communities in the Bay of Fundy until about five years ago. I want to make a case for two particular places based on the experiences of a wide number of people as well as myself, and not that these places are necessarily unique, but they're very good examples of certain things.

Little Letite and Other Passages

I did a great deal of work there over the years, and have done a lot of scuba diving there, as have many of my students, and we have an exceptionally good database for that area. That's probably why I picked it. However, I think an equally good case can be made for any number of passages in the Deer Island archipelago. These passages are very vulnerable to all kinds of damage from accidents, fishing, and they have an incredibly high biodiversity of organisms both intertidally and subtidally. Little Letite is quite a difficult place to work. On the bottom, water current velocities exceed a meter per second, and they're probably double that by the time you get to the surface. These are exceptionally fast water currents, and it means there is a huge volume of water moving through these passages. It also means they're a hazard to shipping, and you don't want to be going through there without power if you can avoid it. Because there is such a huge amount of water going through, it's an opportunity for larval settlement and probably even more importantly, the food supply for filter feeders is virtually inexhaustible. So what you get in these areas is a fantastic population density of filter feeding organisms, and some of these have been worked on. Sponges, in particular, have been worked on in detail, and a new species was described by Brian Ginn. His thesis is available at UNBSJ. He looked in great detail at sponges. And they aren't the only filter feeding organisms there. There's a field of sea cucumbers there - it's virtually paved with sea cucumbers. There are many, many others. And of course they in turn provide another sub-habitat for other things. So the diversity is extremely high. I'm sure there are undescribed species there. If we do look at them in general as worthy of protection, Little Letite might be better than some of the others. First of all, it's a manageable size. It has no present structures on shore, unless something's been put up recently.

Another reason that Little Letite is important is that current velocities are high enough to keep out a large population of sea urchins. Sea urchins have been cited as the organism responsible for creating these "barren grounds," so in the absence of grazing by sea urchins, you get a much better development of small attached organisms on the rock surface. So it's a manageable area, not yet wrecked up. The intertidal is very good, Little Ireland has some nice sedimentary associations around there because it's not out in the most vicious currents. In Little Letite Passage there are some sediments, but very, very little because most are winnowed out by the currents. But there are some large, unstable sand ridges at the inner end of the passage which have large populations of anemones on them at times. It's a very unstable place to attach. These anemones live on the back face, away from the current. I do want to stress that all the passages around the Deer Island archipelago are really special, these places with high current velocity, and it is one of the finest biodiversity areas for benthic organisms in the Bay of Fundy.

Little Letite Passage, Pendleton Passage, all the shorelines of Pendleton Island - we have underwater video transects of that. We have 40 videos probably. There may be more available from Brian Ginn, from University College of Cape Breton. We have the ones he did with us, but he did some on his own, too, and we don't have those.

There's a little mooring near Little Letite Passage and some culture cage sites closer now. Of concern would be the harvesting of sea cucumbers started last year, all the way from Mohawk Island, Black Rock and through the Passages (B.Bosien).

Musquash Head

The history of work at Musquash Head is the history of all the other headlands getting wrecked one by one. We started at Lepreau, and then they built the power station, so now it's virtually useless. In the end, we fixed on Musquash Head as being fairly close to Saint John and accessible. It is a very good place. It has been suggested before as a place that should be protected in some way as a sensitive area. But again, like Little Letite Passage, it's really part of a complex and the whole thing is worth protecting - Musquash Harbour, the salt marshes, the head of the harbour, Musquash Head, Gooseberry Island - that whole area has received a lot of scientific attention. I don't think it has any unique features, but it's an exceptionally good marine environment that has so far not been wrecked up too badly. There's some damming on the salt marshes, by Ducks Unlimited, I think, but other than that not too much has happened. Luckily, NB

Power wasn't able to put a coal terminal in there. So the place is looking fairly good, and is really our only really good headland left, better than the other two we worked on. The coastal flora is exceptionally good at Musquash - all the species and nice effects, such as stunted trees getting bigger and bigger as you go inland, as you'd expect, are there. It's a really nice demonstration area. The intertidal area is quite diverse. The headland itself is moderately steep but accessible and easy to work on, and as you go inland it goes from solid rock to broken rock to sediments. So a terrific variety of environments is there, as well as an exceptionally good selection of tidal pools - from low tide to high tide and everything in between. We use it for field trips. It's a very typical site, with no species unique to science as far as I know, yet unspoiled with a very typical biodiversity. I think we should retain some example of headlands and bay in this part of the Bay of Fundy. It has an exceptionally good salt marsh, and they are fairly few and far between in the lower Bay of Fundy. The database is very good, too. Ph.D. theses have been done in this area - very thorough pieces of work - one on fish in the cove across from Musquash Head, a very thorough piece of work. Tom McEachreon worked on *Ascophyllum nodosum* toughness, breaking strengths round the Bay; changing shell shape and intertidal distribution of periwinkles. Another student worked on *Crangon* at Black Beach. And we've worked on intertidal zonation pretty well throughout the Bay.

David Wildish and Kristmanson have done extensive work on hydrography of the estuary - flow structures, flushing, etc.

There are many video transects that can be used. If they were done with the camera vertical to the bottom, and if you know the length of the transect, and if distances are recorded on the case, you can do quantitative measurements.

Jo-Anne Stevens, Biodiversity and Data Analysis

My interest, mainly, is biodiversity of the Bay of Fundy. I've just made a list of sources of information, including Dr. Thomas'. Hamilton Island, intertidal, subtidal, biodiversity and distribution (32 video transects); Little Letite Passage (11 transects); and Musquash Harbour. Some information is from the marine biology field studies. We have a reference collection, and everything is being re-identified; it's halfway done.

I have data for the Saint John estuary and harbour, Courtney Bay, Letang Estuary, Grand Manan (which I found very biodiverse subtidally), and Minas Basin. This data is from Environment Canada and their environmental effects monitoring reports on pulp and paper mills. This is for species diversity and abundances, which is useful, and some of it spans the course of several years. Roy Parker, Environment Canada, is sending me information next week, all on invertebrates.

I made a list of the Passamaquoddy region subtidal videos: Dr. Thomas' collection - Pendleton Island, Little Letite Passage, Pendleton's aquaculture site, Sandy Island, Richardson's Wharf, Richardson ledge, Letite Passage, Deer Island point, Head Harbour Passage, Fish Island, Dean's Island. Dr. MacDonald has subtidal videos of the Wolves, Deer Island, Penn Island, Sandy Cove, Black Rock and Tommy's Cove.

The videos were done in 1988, so it's something that could be done again, especially since Bob is noticing damage.

Another project is associated with Dr. Chopin at Musquash Head. Videos and transects are being analyzed for algae, but there is more information than just that on them.

Dr. Alan Logan, Head Harbour Passage

I have retired from the University of New Brunswick, but still retain an interest in this area. Firstly, I did some work at Head Harbour Passage, which was published in 1988, and where we did some transects. This was very difficult to achieve because Head Harbour Passage is like a gorge with very steep sides, and goes down to great depths. We have nice 4x photos taken with a Hasselbad, very clear and sharp. I'm in the process of putting these on a CD, so they can be passed around. Secondly, Brian Ginn was my student and Martin Thomas and myself, and he did a lot of work in Letite Passage. Jo-Ann has those video transects, and they should be analyzed. Brian's thesis is available, and there is a paper out. It is in Estuarine and Coastal Shelf Science (2000). I also have a list, which I'll give you, called Key Papers by Our Group.

I've put together over the years my best slides of the benthic invertebrates of the subtidal zone, and I put them on a CD, which is available here. Some of them were taken by Fred Page, DFO. It's a reference set of invertebrates.

The last thing I have is a video taken some years ago by Rabindra Singh. It's a very good survey of what was down there in the early '90s off Simpson Island, so it's a good promotional video to use, if you're going to talk to a group, as it gives a good idea of the biota there. That, too, can be copied.

I would push Head Harbour Passage as an area to be protected. A tremendous volume of water passes through there, and the biota at the bottom are diverse and abundant. Many years ago there was concern that oil tankers might go through there. That idea died, fortunately. It's a key area in our region and one that should be monitored.

Sean Brillant, MPAs and BOF Management.

I work with ACAP here in Saint John. I don't work on any particular physical area, or any project focused on biodiversity, but the organization I work for does some research, both environmental and basic ecological, so I was interested in hearing what is going on. As far as specific recommendations, I don't have any to offer, but I do have some comments.

MPAs

My understanding of the goals of the MPA process is that it's mostly about protecting an area through management. It's not going to be the exclusion of fishing or dragging, but the management of all the activities in the area. So one of the challenges for the MPAs is that this is not necessarily a solution to the problems that you're seeing. For example, the sea cucumber harvest could easily be built into an MPA so the activity would continue, despite the fact that the area is designated as an MPA. These things need to be nipped in the bud. There are a lot of smoldering fires in the background that can be easily addressed early on, such as kayakers around sensitive islands or areas. The idea of mooring signs or warnings might be an example of a simple management solution to adjust a problem that might grow to become much more complicated in the future. Some of these problems can be solved outside of the MPA as well. I think it's important for everyone here to resist thinking that nothing can be done until an MPA is established, or until the location of areas that will be MPAs is decided, but rather that there are opportunities to do things outside of this bureaucratic framework that's being built. I think it's important, especially in this area, that ground is not given. I think that complaints about periwinkle picking, or disturbance of important bird areas is brought up and identified early, and there has to be a line drawn in the sand. You say "this can't be done in this area," or "this must be protected." These management issues have to take into account the fact that there will be people who want to bring scallop draggers into this shallow bay, and that reality has to be addressed. It's easy to say, but it will be very difficult because you'll be involved with all the interested parties throughout the process. You'll be talking with the periwinkle pickers and the scallop harvesters. I'm speaking to issues I'm sure you're very aware of.

Looking at establishing MPAs in some or any or all of these areas suggested today would be a step in the right direction, but just to understand, that would not necessarily solve the problems. Even if Musquash Head becomes identified as a protected area, the management policy has to be put in place which will truly protect it, and not simply manage it well.

Sensitive Areas

Another point I want to make is that people often talk about sensitive areas, and it has come up here. I think that's very worthwhile, but rather than protecting so-called sensitive areas, I think it's more important to protect unimpacted areas, and a good example is Musquash Head. I've had conversations with David Thompson about this. Musquash Head is an unremarkable area in terms of its ecology, but it's remarkable in that it hasn't been adversely impacted. There are probably other areas in the southern Bay of Fundy on this side that should also be considered. Often this part of the southwestern Bay is overshadowed by the upper Bay which is dominated by mud flats, salt marshes, big bird migration areas, and this part is often seen as the aquaculture and fishing Centre. I think it's important and it's great that this information is being collected and brought forward, so people realize that, while this area, which also contains a lot more of the hard substrate than exists generally in the Bay of Fundy, has significant aspects that do need to be protected.

There are issues that haven't come up yet that I think are key to accomplishing a management system or a system of MPAs for the Bay of Fundy. The idea of sensitive areas vs. unprotected areas, the idea of high biodiversity areas vs. low biodiversity areas, and which are more important to protect? Maybe the areas of high biodiversity don't need as much protection because they're more robust ecosystems than the low biodiversity areas, which may be more susceptible to change and degradation. Maybe they're already degraded. Existing impacts within the Bay of Fundy need to be considered as well. The discussion of urchin presence or absence - the interconnectivity of organisms in the Bay needs to be recognized. Bob Stennick, University of Maine, has been doing some very interesting research looking at changing populations of groundfish and urchins and lobster and algae and showing how they relate based on fishing pressures. So the existing regime we have here in the Bay of Fundy now needs also to be taken into account.

I think it's very important that people around this table think there are areas that are very significant and need to be researched. And there is no research; there is no information. The funding for the research sometimes can be put to too many applied processes, and the value of core science doesn't seem to be recognized. Funding and support is needed for these kinds of programs which, for example, would look at the foraging behaviour of birds around Machias Seal Island - we don't know where they go once they leave the island. This sort of need for knowledge needs to be built into marine protected areas to understand that this is a dynamic process of continual learning, continual research. In many cases there are no sources of funding to support this sort of research unless it has an applied application. The MPAs may be a mechanism to get funding to do pure science.

Saint John's Role

The group I work with represents the community of Saint John and much of its outlying areas, and for the most part people I've talked to support the idea of a protected, better-managed Bay of Fundy. As things continue to evolve, and as projects come up, I'd be willing to help people out with finding information. I have no particular favourite area, bug, or plant I'm trying to protect, but I support the process.

I think Saint John sees itself separate from the Bay of Fundy. For the most part, anytime the community begins to recognize its impact on the environment, it tends to focus more on the river and the estuary. There's much less of a coastal presence. But that's partially because in Saint John, actually from Cape Spencer all the way down to Musquash Harbour, the benthos is owned by the harbour and, for the most part, the land along the coastline is owned by the Saint John Port Authority. So, in a way they are detached from their presence on the Bay of Fundy, but it's also partially because there is a physical and a political barrier between them and the Bay of Fundy. People on the outskirts of the city are much more aware of it. I really believe the university here plays a big part in reminding people that they are part of the Bay by bringing students to the shore, etc.

Management Challenges

I notice scallop draggers will drag the mouth of the Musquash as well, just outside a limit line. That's one of the biggest challenges - not only the diversity of the issues, but also the complexity of all the issues. Rather than saying "shut down the East Coast scallop industry" and prevent dragging, perhaps someone can come up with a better invention to collect scallops from the bottom of the ocean.

The right whale recovery plan will be an area that will require a significant amount of management, because it includes the Saint John shipping lanes.

How much has DFO gone with the lessons learned from terrestrial conservation measures? I think that's important to point out. They've been doing this on land for many years, and before we follow the same system and impose a marine system, there are lessons to be learned from their experience.

There are managers with the terrestrial ecosystem as well who know you can't conserve wildlife in a few protected areas, so the challenge is to manage the unprotected areas in a sustainable way. A good conservation plan has a role for protected areas, but it also has a major role for management of the unprotected areas. Take the BC approach to forestry - you set some areas aside and you wipe out the rest of them (T.Diamond).

I think that with a lot of these problems it is the concentration of activities. A little bit of activity is not bad. In the case of nutrients, we need nutrients in the coastal environment, but too much is too much. But how much is too much? To go back to coastal health, some areas are very healthy, others less healthy. We don't have very clear, objective criteria for measuring. What is acceptable? How many cages can you put in a bay before you have a problem? At the present time, everybody goes with his or her little definition, but we know very little about assimilative/carrying capacity of coastal ecosystems (T.Chopin).

Everybody talks about the coastal zone, but it's the last thing that is actually zoned, in the same way that terrestrial zones are. Some suggested we should do the same type of zoning, as for highways. For example, where you have bridges and turnpikes, especially in the US, users pay tolls. Are we ready for users of coastal zones to pay to use them? At the present time many people use, but not too many pay (T.Chopin).

A lot of these places have been recognized for years and years. It's not as if nobody knew that sites like Little Letite are extraordinary. What I don't understand is why has DFO has issued a type of license that will destroy it before you even get started with this process? Why would they issue a license for that type of activity, before the research is done? The person working on the underutilized species initiative (sea cucumbers) should be discussing the areas with the people looking at MPAs (B.Bosien, ed.).

In my own interpretation, the Department of Fisheries and Oceans is an industrial department. Their job, their goal is to get fish out of the ocean, to harvest fish. And only with the *Oceans Act* has this changed. But there is still a barrier. There are people in DFO who think the *Oceans Act* is contrary to what they've been doing for years and years. But hopefully the *Oceans Act* will change this thinking (S.Brillant).

One can sympathize with DFO because there has been a complete change from exploitation to conservation. There's been the same cultural shift in DFO as in Parks Canada, who have had to go from entertaining people in playgrounds to conserving ecosystems. You mentioned resources; you identified the knowledge gap. Is there anything in the MPAs to address these knowledge gaps? For example, if the community identifies critical knowledge gaps that need to be filled before the next step can be taken, are there the resources to do that (T. Diamond)?

We say DFO is a department oriented to exploitation, but at the end it's a political department. At the end, all these quotas and regulations are put in place so you can be elected next time. Also, we are switching now from the mono-specific approach to try to see intereactions, so from one species at a time to habitat to ecosystem. The one species that is common to all this succession of crises is *Homo sapiens*, and when will we try to manage that species (T.Chopin)?

UNBSJ Discussion Summary/Wrap up

Discussion on significant[1] areas brought forth not only the difficulty of protecting pristine areas, but also of restoring heavily utilized and impacted areas. The possibility that some of these areas would be considered for MPA status was not considered sufficient, unless the surrounding waters are managed as well. Good management practices should allow for the use of marine resources in most areas, while still designating some core MPA areas with specific restrictions. The size requirement for any potential MPAs needs to be defined, what is the minimum/maximum size for an MPA to be effective.

Participants also voiced concern regarding the number and variety of initiatives at the present time around the Bay of Fundy. Several of these were listed such as OCMs, MPAs, exclusion zones, study sites, nature preserves, and "biospheres." Many of these initiatives were not very clear, or were considered land-based. All these different initiatives are not seen as coordinated, and, people don't know which system is appropriate in each case. Several participants have study sites that require protection, yet they are not adequately protected from industrial activities. Rockweed study sites for example, are in place for the time of the study, while an exclusion zone is for a much longer time. This is an arrangement between Federal and Provincial departments, and the seaweed and aquaculture industries. There are all kinds of agreements, consensus or negotiated settlements, but again there is no overall general plan.

The role of MEQs, or Marine Environmental Quality indices, was also discussed whereby certain guidelines would apply while engaging in an operation inside a significant[1] area.

The precautionary approach, and when and how to apply it, was seen as related to the concept of what is acceptable or not. For example, an Environmental Organization will not have the same definition of acceptability as a marine industry; and different industries will disagree. Specific threats were also discussed in context of significant[1] sites identified.

Further questions and concerns are listed below:

- How would MPAs be managed, would some developments/activities always be excluded?
- How effective is DFO going to be in protecting these areas, considering that there are now licences for underutilized species (such as sea cucumbers) for which very little is known.
- There are areas now being dragged that were never dragged before, and no one is looking at the impact of this increased dragging in areas that were previously untouched.
- Too little too late, new areas and new species are being impacted that were safe before.
- Need to document these new threats and areas being impacted by new or increased activities.
- Too many new developments on the Bay: automated feeders and seedoos which increase noise levels; ecotourism, whale watching, kayaking and commercial and recreational boating; aquaculture, rockweed harvesting, dragging for new species in areas previously untouched. The cumulative impacts of all these activities must be studied.
- Would an MPA surround an area of two square kilometers, or would MPAs be the size of National Parks?
- How can study sites be protected? Most are very small, a little pocket here, a little pocket there, and these sites can not be integrated into a larger one.
- The sources of problems for the Bay of Fundy must be looked at, or what is the point of protecting anything, or having these MPAs?
- How much are we willing to live with in order to have the industries provide jobs and economic resources; and what is the difference between what is ecologically acceptable and what is minimal compliance.
- These is an increase in impact everywhere, periwinkle harvesters turn over rocks and use ATVs. By decreasing the pressure of grazers filamentous fuzzy algae can thrive.
- Harvesting of sea cucumbers by dragging, all the way from Mohawk Island, Black Rock and through the Passages, in areas recognized as highly biodiverse.
- Can highly utilized areas still be protected? Need a baseline, reference points, to assist in regulating the impacts on the organisms.
- There are too many reports of illegal shooting of harbour seals and herons.
- The increased level of noise pollution from increased boat traffic, aquaculture automatic feeders, and seal scares should be studied; potential impacts on marine birds, porpoise and whales.

SACKVILLE, NEW BRUNSWICK WORKSHOP AND SUBMISSIONS

Canadian Wildlife Service
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Dr. Peter Hicklin, Shorebirds and Mudflats

(Figure H.4, and submissions in Appendix H-iv)

(Transcript of presentation not available due to microphone malfunction. However, much of this information was submitted through the site-specific questionnaire - Editor.)

Mudflats play a very important ecological role; perhaps there should be several mudflat areas or salt marshes, in different locations, which together would be an MPA area. For example, Daniel's Flats is a massive area of salt marsh that I think plays a major role in that ecosystem. We've lost so many salt marshes over the last hundred years that they really should be protected and they're quite separate one from another.

Some areas are more productive than others. The changes are great - in the twenty years I've been doing this, Grand Anse is unrecognizable from what it was. Twenty years ago it was a very productive mudflat, today it's not. A lot of it has to do with the opening and closing of the gates on the Pettitcodiac. To me that just shows why they have to be kept as they are. We've lost one already. Although I work for shorebirds, I suspect quite strongly that this mudflat is relevant to the whole Bay and its waterfowl, the fishery and shorebirds.

Roughly half of Daniels Flats is already owned by conservation organizations. So by default, we'll be looking at access, because they're talking about landing those giant hovercrafts at the top (C. MacKinnon).

Josette Maillet, Areas Managed by Nature Conservancy of Canada

Basically, NCC works to secure lands in the Upper Bay and especially in the Johnson's Mills area, mostly beachfront and upland properties, or roosting areas. (Map available of a number of areas already secured by acquisition). We're also looking at properties around the Minas Basin in Nova Scotia - shorebird habitat - and around Evangeline Beach and Blue Beach. In addition, we're beginning to concentrate our efforts in the Musquash area. Regardless of whether it's going to be an MPA or not, we're looking to secure some of that upland area as a buffer to the property that's already been acquired through the EHJV and the DNR, as well as some offshore islands in the area and some salt marsh. Besides that, there are some offshore islands in Passamaquoddy Bay: Pendleton, McMaster and Simpson Island, and a few others.

People who are concerned bring areas to our attention. We then complete an environmental and a site assessment to determine whether we consider the area to be ecologically significant. There are landowners who wish to see certain properties protected.

I'd just like to point to the important role that the Nature Conservancy is playing. As a result of cutbacks, it's been very difficult to protect through acquisition over the years, and the NCC has come through and made it possible. Their role has been very significant. Nature Conservancy gets to know about the importance of some of these areas when we are approached. We were approached by Bob Bancroft and Bill Schultz and we actually walked the areas. I showed them what we had. But they specifically contacted us and asked us what areas we considered important. Any areas dealing with seabirds, can be passed on to us, or to John Sharkey. That's where the data centre would come in - there may not be someone to answer specifically, but the data centre would have the information, such as aerial surveys for a certain geographical area. All my data are available from the CDC. Information at the data centre is available to the general public (P.Hicklin).

Alain Caissie, Fundy National Park

We are interested, but don't have any formal information to submit at this time. Management of the park has evolved over the years from concentrating within our boundaries to a broader ecosystem approach. We've certainly done that on the park's three forested boundaries in partnership with the Greater Fundy Ecosystem Research Group, the Fundy Model Forest and a number of different initiatives where we are looking at alternate management of the forest around the park. The park can benefit from, and supports, the implementation of the Forest Management Guidelines to Protect Native Biodiversity (GFERG) and the NB Protected Areas Strategy.

On the park's fourth boundary, the bay, the official park boundary stops at the mean high tide line. We would certainly like to move out into the Bay from our boundary, in terms of multi-stakeholder ecosystem management, in the same way that we have on the park's three forested boundaries with the FMF and the GFERG. We certainly support in principle any marine conservation initiatives and would be interested in taking part in any similar forum, as we do in terrestrial ecosystems.

We have intertidal transect data and a lot of interpretative information on the intertidal zones, through naturalist activities, and through the museum and publications of species lists.

There is a Marine National Parks initiative being developed by Parks Department in Ottawa; it may complement some of the work we're doing.

The interpretative program places about half its emphasis on the shore and the bay. The park did have an ecosystem survey done back in the late 70s or early 80s. A consultant did surveys of plant and animal abundance and distribution on the intertidal zone and may have done some subtidal work, too. There was a report and a few copies are available in a few parks' offices, in the library, etc. We'll look for it. It was a maritime firm that did it. *(Editors: Carter, J.A. and C.D.R. MacGregor. 1979. Resources Inventory of the Intertidal Zone of Fundy National Park. MARTEC Limited, Halifax, N.S. 328 pp. Available from the Biological Station Library.)* I think that because of the national park on a strictly protected area on the land, a marine protected park could be adjacent to that. They would complement each other (D. Christie).

Other than the existence of the existing park, what would be the argument for making the marine segment a park? What is unique about the marine environment in that area? Is there a large marine bird population (K. Davidson)?

I don't think there's anything unique about it, just that it would be good for education and the land park is already there (D. Christie).

There isn't any large marine bird population. There is land-based protection, but there's no marine component that might protect the marine portions of the life cycles of animals in the park, if they use marine areas for feeding, for example (A. Caissie).

There is a lot of information available from the NACS initiative.

Kate Bredin, ARCAD Database

ARCAD is a geographic database. Most of CWS's bird data is in GIS form or tabulated form. We have lots of plant data, but I don't think that would be of use to you. We have an ARCAD database, which our database manager has added values to. Basically, we have those resources related to seabirds, shorebirds, etc. and just keep updating them. We just got money for the GOM project. That project consists of mapping rare endangered and/or keystone marine vertebrate species in the Bay of Fundy. I've started by preparing a species list for marine fish. People pretty well know what marine mammals are there, but less is known about what marine fish are there. The next step is identifying sources of information and which species are keystone or endangered, and finally mapping the data. We're using the WWF seascapes as basemaps.

Sara Richard, Eastern Habitat Joint Venture

(Figure H.5, and submissions in Appendix H-iv)

The map below shows areas that the joint venture has been or will be focusing on for securement. We have selected areas of individual interest, and many overlapped. For instance, around Grand Manan and Blacks Harbour, St. George, and coastal islands in the case of birds. We've been working in Musquash and the Nature Conservancy is a partner with us now. There are some salt marshes along Chance and Dipper Harbours, and bits of salt marsh along the Bay of Fundy that we've always been interested in. We've been trying to get the large 150 acres marsh at St. Martins, and around Garden Creek. Shepody Bay is one of our key focus areas through our various partnerships. The joint venture does own several parcels of the salt marsh at Waterside Marsh. We've bought parcels of salt marsh near two national wildlife areas in the vicinity of St. Mary's Point and also along Daniel's Flat. NCC bought parcels at Johnson's Mill. This is an area we've been interested in for quite a while. We look at land ownership and the wildlife resources for each of these key areas we're focusing on.

We have purchased some coastal islands, like the Brothers Islands near New River. We don't have a lot of the islands mapped in this area, just the Brothers. There are islands off

Grand Manan that are owned by Natural Resources, but haven't been designated under wildlife jurisdiction. We want to look at this and get that transferred into the wildlife jurisdiction. High Duck Island and Low Duck Island are both Crown land. So we also want to go through the process to identify Crown land which isn't designated.

These are arbitrary areas that we felt are generally threatened and that we've been looking at recently. They're not all available and we don't have a presence on all of them. I just outlined what criteria we use in order to acquire property generally -- it is not just that they may be available, they are sensitive areas. We figured any salt marsh we can get our hands on is important (Figure H.5).

There's not that much salt marsh left around the Bay, so we try to get whatever we can. We also own property on the other side of the Bay, through the Eastern Habitat Joint Venture and Ducks Unlimited partnerships. We haven't got that mapped out, though. The NWA, a group of properties around McCann, River Hebert areas. One thing that would be useful is to have a look at the Service New Brunswick system. It covers all around the perimeter of the Bay, giving information on ownership. It doesn't show the ARCAD information. But it could be cross-referenced to get the legal owner for all properties. If a coastal island is owned by one person, it's not a big problem, but some have multiple owners, so it's more difficult. You should also get in touch with the NB Nature Trust to see what areas they have already. The NCC just bought two islands, or one was donated, probably Pendleton and McMaster. The NB Nature Trust also signed Green Island - I couldn't find it on the map. It may be known by another name. We're also in the process of looking at all the Coast Guard properties, such as South Wolves (K.Davidson).

Ile Haute

The Nova Scotia Museum and Acadia spent time on Ile Haute. (Editor: this site has been identified through the Conservation Biology Insititute --CBI-- as a potential MPA). There are unique flora and fauna. It's under Coast Guard jurisdiction now. We have a list of flora and fauna put together three or so years ago. The NS Museum had a research scientists' think-tank session a couple of years ago where a group went out for a week. They recently published it, and this is all the current research. It can be had from them for about $10. There's a peregrine nest there. We've got a number of sites we'd like to get to. Ile Haute and Grindstone are two of them. Ile Haute is a very difficult site to get to. There is a tour that goes out there, www.ilehaute is their website. There is information available through CWS (C. MacKinnon, K. Davidson).

Grindstone Island

The Coast Guard owns four acres, but the remainder is owned by the Anglican Church in Sackville. The Church owns the 50-acre island, and also all the rocks and regions around the 230 acres of flats, which is an unusual situation. It's because of the grindstone industry, so stone could be accessed below tide. It was granted in the original charter.

We've been unofficially going out three times a year to examine bird colonies there (C. MacKinnon).

Kevin Connor, Crown Land-use Leases

My attendance here is a fact-finding mission. My involvement in the Bay of Fundy is largely through proposed crown land-use leases, which deals with proposed aquaculture sites and the rockweed harvest in and around Passamaquoddy Bay, Grand Manan Island, and southwest New Brunswick generally. I've been looking at eider distributions and their relation to these industries and trying to plot management zones or proposed critical breeding areas for Common Eiders in the Bay of Fundy. We've generally kept any of the bird information that we have and we disseminate it to the Colonial Waterbird Database at CWS. Resources that you may or may not have would include DAFA, and Tom McEacheron (rockweed). They've done a great deal of work estimating bycatch and they have species lists on fine resolution maps by harvest sector. And Glen Sharpe, DFO, is involved with that.

I think there is a recent publication by Mawhinney and Sears on that first incidence of breeding population of Razorbills in Canadian Naturalist. *(Editors: Mawhinney, K. and D. Sears. 1996. First nesting of the Razorbill,* Alca torda*, in the Wolves Archipelago, New Brunswick. Canadian Field-Naturalist 110: 698-700.)*

We're involved through the rockweed management committee and it's a different approach to the MPA strategy. It's more of an integrated approach to resource protection. For example, they limit their rockweed harvest by sector, with exclusion zones and timing of harvest taken into account. Right now the strategy is only directed at the rockweed harvest. I'm very interested in the cumulative impact of multiple user groups on marine resources, so we're trying to build a database that looks at the user activity and aspects of the different regulated fisheries. We're attempting to plot that with bird distribution.

Tony Diamond has a master's student right now who's monitoring various activities and attempting to quantify the impact of the disturbances from these activities on seabirds. There's a group of us trying to gather all that information together.

Our initial interest was for Common Eiders during their breeding season, since this is the only colonial nesting sea duck in the Bay of Fundy. So that was our initial interest, and we were trying to regulate the rockweed harvest to avoid the critical breeding areas and times. From early on we realized the rockweed harvest was just a small component of a lot of other resource user groups. One of my problems has been that everyone has different zones for different purposes.

Glen Sharpe would be the contact for an overview on the distribution of effort and planning. The project started out from a different angle and we're looking at overall disturbance, as it evolved Glen was the closest to the different fisheries and can get that information.

Dave Christie, Significant Bird Areas

(Figure H.6, and submissions in Appendix H-iv)

I'm most intimately connected with the Shepody Bay project and adjacent area, which has been coming up over and over again here today. Mary Majka put together a sketch of what she feels is the significance of New Horton-Mary's Point Flats and Grindstone Island area in particular. It's background information. There is a lot of information about this area out there.

I tend to see the Bay of Fundy more in terms of birds and marine mammals, rather than the benthic resources. The ones that seem to me to be areas of sensitivity are the shorebird concentrations in the Upper Bay, intertidal habitat of Maces Bay, which relates to the two nesting colonies of eider.

Then I see the whole area of Passamaquoddy Bay as a very important area for sea ducks, gulls, sandpipers, phalaropes, etc. and the offshore areas of Grand Manan, the ledges, Machias Seal Island - the whole area east of Grand Manan is very important for a variety of aquatic birds. Kent Island and many other small islands all relate to the richness of the sea.

Machias Seal Island

There is lots of upwelling of currents in those waters, so they're very important to birds that nest in the area (D.Christie).

Tony Diamond probably addressed the issue of intuitively feeling that there is something going on at Machias that we should protect. Puffins are seen feeding around Machias, for example. Because it's international, it's actually relatively well protected because of, rather than in spite of, its lack of clear jurisdiction right now. I've spent a lot of time on this area lately, dealing with various government departments and user groups, and it's very complex. We've been studying that area for years and I'm aware of nothing that shows any significant effect on the bird population from fishing (K.Davidson).

Both countries fish around the island. We have one of the healthiest seabird colonies anywhere in Canada on Machias. I think there was a drop in the early 80s and then the puffins returned and everything's gone up ever since. That might reflect on the other colonies. There's a lot of movement between the colonies. Some long-term monitoring should keep track of it. Overall the puffin population seems to be in really good shape, although we need to get a better handle on the numbers and their food abundance (C. MacKinnon).

Sackville General Comments

The Krill fishery

If a fishery developed for the macro-invertebrates that these animals eat, this would affect seabird populations (D. Christie).

The krill fishery proposed a while ago would be horrific. Anything based on a fishery at that level would be very harmful. The petrel colonies on the south coast of Nova Scotia and Kent Island would be very affected by such a fisher (C. MacKinnon).

Under-utilized species will probably be a major issue (K.Davidson).

WOLFVILLE, NOVA SCOTIA WORKSHOP AND SUBMISSIONS

Acadia University, Wolfville, NS
April 6, 2001

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Dr. Mike Brylinsky, Minas Basin Integrated Management

My expertise is marine ecology. Relative to MPAs in general, I'm also a member of the BOF Ecosystem Partnerships Working Group, which is a subcommittee of BoFEP. One of the objectives of that committee is to try to develop some sort of integrated management plan for the Minas Basin. Two comments relative to MPAs: to be effective, they have to be a part of the broader integrated management (IM) plan. Secondly, an IM plan has to be based on knowledge of how a particular ecosystem works. A management plan has to be based on science. If you want to manage, say, a flounder population in a particular area, you have to know where that stock spends its time. Where is the feeding area, where is the nursery, where is the wintering area. In many cases, we don't have that information so there has to be research to identify knowledge gaps, and programs to fill the gaps. The geographic area is something that expands and contracts, and it has to include the area that is important to the ecological integrity of that particular resource that we're trying to manage.

Glanville Travis, Fisherman, Retired

I am on several of the same committees with Mike Brylinsky. I agree with the comments made by Mike.

Ottawa should say these are MPAs. Now, how do we manage them? DFO is the regulator, the lawmaker, if not serious in setting up MPAs they should stop wasting our time. MPAs are to be nurtured? (Editor not sure of word) and worked with, we shouldn't be scared off. We shouldn't be talking gravel extraction in the marine environment; a lot of watering down (of conservation) happens (G. Travis, Pers. Comm, Apr.6, 2001).

Trish Turliuk, Concerned Citizen

I'm currently starting a business in visual media production and consulting. I like the idea of Marine Protected Areas, but I think they should be ecologically functional. I would like to see an integrated approach, from the top down, and where research identifies the areas that are ecologically significant first, rather than from the bottom up, with bunches of small MPAs. I like the idea of bringing communities in as partners. I hope that communities are given the opportunity to see the larger picture, and that it's not perceived as just "their backyard" that should be protected.

Dr. Robert Rangeley, World Wildlife Fund

I'm a marine ecologist by training, and have done a lot of my marine work in the Bay of Fundy on fish habitat, mostly in the intertidal zone, on marine fishes and most recently, lobsters. I'm now with the World Wildlife Fund. The focus of the Halifax office will be on marine conservation. One of our key areas of focus and interest is MPAs. We have to keep important distinctions in mind in the examples outlined for us in what I'd call ad hoc areas, such as Musquash and the Gully. These have been identified as ecologically important areas and as areas of quite a lot of resource use, where there's a concern over ecological integrity; hence, ad hoc. For these sorts of areas and for identifying other sensitive areas, I agree with Mike that more science information is needed, and that the need for protection should be science-based in terms of understanding distributions of organisms and boundaries and management frameworks for protection, and in order to get it right in terms of spatial and temporal scale, like fisheries.

But I think that to be truly effective for marine protected areas, if we do want to go on to a network approach, it's completely unrealistic to expect to implement an MPA based exclusively on ecological knowledge. We're just not going to get there in the timeframe necessary for protection. If we're going to take a precautionary approach, we're going to need another type of framework and model for implementing future MPAs. Those MPAs should be in a network, a system approach, and they also have to fit into an IM approach. So one way of doing this is WWF's suggested framework based on representative habitats. DFO hasn't necessarily bought into this. The big advantage of this kind of approach, rather than being based on species distribution and biodiversity, is that it's based on representative habitats. With this approach in your planning of MPA and such networks - however they will be defined - you're protecting areas that represent key features that are used as habitat by many organisms. So you protect habitat and the key features that animals require. You don't have to fully understand distributions, abundance and densities and their variations in order to put protection into place. In order to get things happening soon, it's a good approach, and meanwhile, research can continue to take place within the area. There are a lot of problems coming up with protected areas based on our quite limited ability to measure, and the resultant statistics which have high error potential and can change so radically over time. The representative habitats approach is based on a seascapes approach, on enduring features, things that are there over the long term (the benthic) and major features in the water column as well. It's an approach that the Oceans group acknowledges, but hasn't necessarily bought into.

I'm not saying other things don't have to go on. But if you protect the places that organisms live in, you've captured the essence of what is necessary. Of course research has to go on, and integrated management has to be in place, too. I think we recognize that there is a considerable urgency to get protection now, and if we adopt a precautionary approach, then I can't see any other way than accepting representative habitats as a basis for getting protection right now.

Daniel Rainham, World Wildlife Fund

I'm an epidemiologist and public health person by training, specifically in air pollution and human health issues. I'm with WWF for the next year, helping with analysis, inventory of geo-reference data, statistics, and to help them expand their habitats model. There are a lot of interesting research questions that arise from these issues, and I hope to use my statistical experience to help with some of them. I was in the branch of DFO in Ottawa for several years when they were developing the *Oceans Act*, so I'm familiar with the ideas of MPAs. I worked with Chris Moran on coastal zone management.

One of the powers of GIS is the ability to integrate many forms of information, but first a survey has to be done of data and online inventories. A lot of inventories online are not geo-coded, so a lot of work has to be done there. One thing about GIS in terms of decision making is that you can simulate interests. You can incorporate interests of those involved separately, with their own parameters. GIS can simulate the areas based on the weighting of parameters given by interest groups. So you can show people, if you do it this way, this is what it will actually look like given different parameters. We can run simulations over time. Visualization is very helpful to understanding. It's not just mapping.

Kimberly Woody, Leatherback Turtles Research

I don't think the marine turtles utilize the Bay of Fundy a lot. Sighting data indicates that leatherback turtles stay near shore in the mainland US area and seem to bypass the BOF and come up the Atlantic coast along NS. Perhaps they do use the Bay, but we rely heavily on fishermen and coastal community residents to report sightings. Maybe there aren't any sightings, but maybe some sightings aren't reported. So we may be missing areas where they actually are found. We'd like to get a lot more participation from fishermen and residents in reporting sightings. Our efforts are initially spent first on canvassing the whole province, and then where there is interest, we concentrate on that area, so the lack of sightings could be a fault of our data collection method. Perhaps they do come into the Bay of Fundy more frequently than we realize.

Wolfville General Comments

MPAs and Integrated Management

Ecosystems are all linked with one another. Are the areas that will not be protected the ones that are over-exploited? Establishing a marine protected area is not going to lead to a sustainable fishery, unless the entire Bay of Fundy ecosystem is protected and managed in a particular way. Protecting an estuary may help somewhat, but protecting the estuary, which is a nursery for a particular species, without protecting the species outside the estuary, won't accomplish much. Extremely critical habitats, particularly ones that are subject to exploitation, need special protection. But we should deal with habitat deterioration where it is occurring, and with the kinds of activities causing the deterioration. Rather than dealing with specific places, we should deal with specific activities. Use this analogy: a chain that keeps a weight from falling is subject to corrosion - if you protect 99 links of a 100 link chain, the unprotected link ultimately fails, the whole chain fails and the weight falls. We need more than just MPAs established to do the whole job. One could understand the practicality of setting up an MPA in a small geographic area, but for them to serve a useful purpose, they have to be part of a larger area of integrated management. "Conservation" might be a better word to use than "protection," and to make it more acceptable, it should be made clear that a protected area would be part of a larger plan. BoFEP has a committee to deal with Minas Basin. The objective is to come up with the integrated management plan for the entire

Minas Basin, and to identify all its resources. Community workshops and projects to identify stakeholders, people who are actually involved in activities that impact the area, are underway. The worst-case scenario would be if something is put in place, but it doesn't really have an effect, but DFO can say it is doing something (M. Brylinsky).

A network of small areas might consist of MPAs each with its own design criteria, such as a core area and buffer zones. A large MPA might have smaller core areas, then areas of confluence. The biggest stumbling block would not be the existence of one big MPA or a network of MPAs, but the uncertainty, the lack of a plan for the future, in relation to industry's need to develop business plans for the future. The whole purpose of an MPA should be made very clear, and it's not going to work if it's simply by consensus of all potential stakeholders. Placing lines on a map doesn't protect ecosystems, there have to be minimum standards and true ecological protection. It's important to get input from stakeholders, but a consensus is never going to be reached. It's been said before *("If it's watered down, it's not going to do the job" Editor.)*, but it's important to keep your eye on the target. But because you have to get input from the stakeholders, it's even more critical to have a defined plan, based on logic and science (B. Rangeley).

For example, a shorebird comes down from the Arctic, spends two weeks feeding on mud shrimp here in the Bay before heading to South America and it doesn't touch ground until it gets there. So the two weeks it spends here are critical. The designation of a biosphere reserve for the area would have no meaning - people fish for flounder there, people walk all over the shore, people dig bait. The designation is there, but it carries no weight, no authority. It doesn't mean anything. It's recognized, but there's no active protection.
I think DFO should begin development on an Integrated Management Plan, and get some resources to do it. I really do have that fear that the impact of these MPAs is not going to be large if they allow so many activities. And they'll be too small, and they won't have links to protect the fisheries. You can save all the estuaries you want, but if you don't protect the pelagic and the benthic systems from certain activities (i.e. dragging), the estuaries are useless as nurseries (M. Brylinsky).

Biosphere Reserves

There is a narrower definition when you're looking to protect an actual space, called a sanctuary; and the global designation of Biosphere Reserves, by UNESCO, doesn't actually have any actual legislation associated with it. It's strange not to have MPAs in something that has been designated as a world biosphere reserve. It's obviously an area of high need (B. Rangeley).

Mapping and Models

There is an ecosystem model and single species approaches, and population viability models used to calculate extinction curves, probabilities and risks. In terms of MPAs, I can see those models certainly being relevant, to look at extinction curves and probabilities for key species as an exploratory analysis. Often these MPAs focus around one or two species. The umbrella species concept works well. Laws in the US are much stronger for protecting species. From a population point of view, it's a big advantage to be able to see the results of choices. Models are more powerful now. One problem that came up early in the world of designing nature preserves was that you can end up protecting the wrong population, and redirect fishing effort into the wrong area, the vulnerable source area, which explained why populations were declining in some cases (B. Rangeley).

A lot of research I've been doing over the last three or four years was on a climate change impact model - changes in temperature, sea levels. This is a big issue, incidentally, which could have a big impact on MPAs in the future and no one has brought it up here. How do areas change over time? You can use some of these climate change models. I assume this model would be appropriate when it comes to habitat as well. It's more complex, and there's uncertainty due to a lack of data, but you have to start somewhere. But we could start by trying to focus on what's out there at the moment and apply some of these models on a small scale (D. Rainham).

I've had a lot of experience in numerical models, and I know the limitations. Twenty years ago it was a panacea, and nowadays everybody says it's a heuristic value. If you did it on historical data and community succession, you could see how an entire habitat did change (M. Brylinsky).

They have been used wrongly as a predictive tool, and without really understanding the model too well. They are very data sensitive. They're appropriate as a tool for trying out scenarios. For example, they could be used to show stakeholder different scenarios in MPAs, showing the results of changes to boundaries, fishing effort, fishing location (B. Rangeley).

WRITTEN SUBMISSIONS BY VARIOUS INDIVIDUALS

Dr. Thierry Chopin, et al. Maces Bay, Letite, Grand Manan

Dr. Thierry Chopin, Gary Saunders, Colin Bates, and others students.
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Profession/area of expertise: Psychologists (research and teaching on algae)
Ecophysiology and biochemistry
Integrated aquaculture
Molecular biology/systematics

Site name: Maces Bay, Letite, Grand Manan
Where: Chart submitted
Maces Bay Exposed site (Welch Cove), Sheltered site (towards Lepreau Harbour)
Letite: Exposed and sheltered sides of the Light House (Green's Point)
Grand Manan: Castalia (sheltered site)
Harrington Cove (exposed site)

Long-term biodoversity studies/monitoring changes in the Bay of Fundy by underutilized, but very appropriate bio-indicators: seaweeds.
Ecophysiological and biochemical studies of seaweeds of economical value such as rockweed (*Ascophyllum nodosum*) and Irish moss (*Chondrus crispus*).
Keeping reference sites with minimal anthropogenic impacts.
Note: what does areas of high biodiversity mean? For example, Brittany in Western France is a floral transition zone with more than 800 inventoried species of seaweeds. The Bay of Fundy has a macroalgal flora that is around 80 species. What should we conclude in terms of biodiversity when comparing these two regions? Numbers of species are not everything…! Moreover, biodiversity is not necessarily an indicator of "sensitivity requiring preservation." Low biodiversity areas could also be critically sensitive.

Many references and data available through Drs. T. Chopin and G. Saunders.
Concerns, threats: nutrification, siltation, eutrophication, etc. of coastal waters (Bates, Chopin and Saunders, 2001).
Cumulative threats (each activity in itself is not seen as harmful, but area is subjected to an increasing number of potential harmful activities): certainly!
Interested parties: research, teaching, harvesting, aquaculture, and recreation.
Note: it is more than time to co-ordinate various initiatives around the Bay of Fundy: OCM, MPAs, rockweed exclusion zones, rockweed study sites, Nature Preserves, UNESCO Biosphere, etc. to develop an integrated plan.

Is this area already managed under a specific initiative or regulation: Maces Bay Ledges is already a rockweed study site.
Management recommendations: the sites used in our work are relatively small to make them MPAs, but they should be part of the network of OCM/MPAs/Biosphere because we intend to use them for long-term studies (this kind of study is critically missing). Voluntary guidelines with the industry are definitely to be reached by consensus (or would the term "negotiated settlements" be more appropriate?).

Colin R. Bates, Thierry Chopin and Gary W. Saunders

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Conservation in the Bay of Fundy: a macroalgal perspective.

Seaweeds are an important component of the Bay of Fundy's intertidal zone, both ecologically and economically. Concerns that the increasing pressures on the Bay of Fundy are adversely affecting seaweed communities have prompted us to implement a seaweed monitoring program. We are monitoring six sites within the lower Bay of Fundy, New Brunswick, specifically Letite (exposed and sheltered), Lepreau (exposed and sheltered) and Grand Manan (exposed and sheltered) indicated in Figs. H. 1a-c. We are using transect and quadrat based methods to assess quantitative and qualitative change in seaweed communities within and between sites over time. A more detailed description of our methodology is outlined in Bates et al. (2001).

Schramm & Nienhuis (1996) have documented Western European coastal biotic communities recognizing the following indicators of anthropogenic pressure: 1) a reduction in lower intertidal and subtidal red algae, and decline or disappearance of certain perennial algal communities, 2) blooms of short lived filamentous algae, such as *Ectocarpus* spp. and *Pilayella littoralis* (Linnaeus) Kjellman, 3) increased number and density of benthic filter feeders (*e.g.* mussels) and detritus feeders (*e.g.* sea urchins), 4) green tides (extensive blooms of *Enteromorpha* spp., *Ulva* spp., and *Cladophora* spp.) and 5) a general impoverishment of the flora, and a reduction in species numbers and diversity.

Monitoring the six sites on three occasions (May, August, & November 2000), has revealed a number of things. Firstly, the Letite sites are showing symptoms of stress consistent with 1,2, 3, & 5 listed above. (Bates et al., 2001 for further details). Secondly, the Grand Manan exposed site is not exhibiting these symptoms, and is the most diverse of our sites. The Lepreau exposed site is providing a mainland reference to the Letite sites, and is exhibiting intermediate diversity.

It would seem that the Grand Manan sites are, as yet, not degraded and still exhibiting high macroalgal diversity. We recommend that efforts be made to maintain the diversity at the Grand Manan sites. It also appears that the Letite sites are being altered by the pressures exerted on the New Brunswick coast of the Bay of Fundy. We feel that the Letite sites should be considered for alleviation of anthropogenic pressures should this become relevant.

Seaweed Conservation Recommendations

Seaweeds have a number of requirements for success. These requirements include light, nutrients, substrate for attachment, recruitment potential, and respite from herbivores. Our recommendations stem from an attempt to maximize these facets of algal life. A reduction or prevention of any activities that negatively affect the ability of algae to gain these requirements will presumable lead to an increased survival and success of algae. This protection can come in either spatial protection, such as marine protected areas, or in temporal cessation of impact inducing activities, allowing a phase of recovery. Such a recovery phase would presumably not take a long time, as marine algae are generally adapted to life in a high disturbance regime. Specifically, we would like to see a (temporal/spatial) reduction in activities that contribute to the following conditions:

a) Siltation – siltation can reduce light penetration into the water column, lowering photosynthetic capacities of subtidal and intertidal seaweeds. It could also presumably alter the effective photoperiod that algae experience. Silt can also have abrasive effects on algae.

b) Eutrophication – excess nutrient input can stimulate algal blooms and opportunistic epiphytes. These algal blooms can compete with other algae for light and space, and the epiphytes can increase hydrodynamic drag on the host plant, increasing the likelihood of being dislodged from the substrate.

c) Input of organic particulate matter – continuous input of organic particulate matter can stimulate excess growth of filter feeding organisms such as mussels. Mussels compete with seaweeds substrate, and can potentially filter out dispersal propagules, reducing recruitment and dispersal. High levels of organic particulate material can also lead to blooms of detritivores such as sea urchins. Sea urchin blooms can heavily graze seaweeds as well, resulting in subtidal "urchin barrens."

While it is difficult to reconcile the needs of all groups of organisms (including humans) into a management regime, we hope that these outlined points will be considered in any forthcoming management plans or conservation efforts.

Bates CR, Chopin T, and Saunders GW (2001). Monitoring seaweed diversity in the Bay of Fundy, New Brunswick, Canada. p.163-176. In: Opportunities and challenges for protecting, restoring and enhancing coastal habitats in the Bay of Fundy. Proceedings of the 4th Bay of Fundy Science Workshop, Saint John, New Brunswick, September 19-21, 2000. Chopin, T. and P.G. Wells (Eds.). Environment Canada, Atlantic Region Occasional Report No. 17, Environment Canada, Dartmouth, Nova Scotia. 237p.

Dr. A.W. Diamond. Quoddy, Machias, North Grand Manan, Maces Bay, Pocologan

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Profession/area of expertise: Research Professor, Wildlife Ecology

Site name: Machias Seal Island
44 30'N, 67 06'W, chart submitted.
Description: ISLAND 18.75 km SW of Southwest Head, Grand Manan.
Approx. parameters: 16ha.
Marine structures: delapidated landing jetty
Land structures: lighthouse, two houses, 1 storage shed, helipad.

Why

Major nesting site of seabirds; research site; migratory bird sanctuary.
Critical/significant habitat: Terrestrial habitat described elsewhere; marine habitat undescribed.
Single species importance: Razorbill *Alca torda* (40,000 breeding pairs in North America); Atlantic Puffin *Fratercula arctica*; Arctic Tern *Sterna paradisaea*; Common Tern *S. hirundo*. Razorbill and Arctic Tern are species of regional concern.
Biological/ecological characteristic: Breeding grounds.
Biodiversity: Yes, bird and plant lists exist.
Visualization: Colour aerial photos.
Description: Description of marine area not found.

General References/Data available: Progress Reports, and Research Protocol, from ACWERN, summarise available information.
Non-biological or non-ecological factors: Scientific /conservation significance;

How

Concerns, threats: Ecotourism currently tightly regulated; fishing in surrounding area is current concern.

Are any of these threats cumulative?
Interested parties: Conservation; ecotourism; research; fishing. Site of jurisdictional dispute between U.S. & Canada. Manning of lighthouse responds to this.
Is this area already managed under a specific initiative or regulation? Migratory Bird Sanctuary under Migratory Birds Convention Act.
Management recommendations: Suggest restrictions on fishing in surrounding waters (5 km radius).

Site name: The Wolves Archipielago

Where: 44 56'N, 66 44'W to 44 59'N, 66 41'W, attached chart
Description of location: 5 islands centred 19 km north of Grand Manan Island.
Approx. parameters: ca. 3.5 sq km
Marine structures: several herring weirs
Land structures: Few cabins (mostly on East Wolf)

Why

Major breeding area of Common Eiders *(Somateria mollissima)*, important wintering area for Harlequin Ducks (*Histrionicus histrionicus)*

Critical/significant habitat: shallow water immediately inshore used by harlequins in winter, by eiders in summer.

Single species importance: eastern population of harlequin is listed as endangered by COSEWIC.

Biological/ecological characteristic: Wintering area.

Biodiversity: Could be provided

Visualization: Aerial colour photos available.

Description: Five small islands, four forested. Uninhabited except for fishermen and local residents in summer. Surrounding seafloor falls steeply away from shore, providing limited areas of rockweed. Double-crested Cormorants, Herring and Great Black-backed Gulls, Razorbills, and Bald Eagles also nest.

General References/Data available: Several publications from recent ACWERN research: Mawhinney, K. and Sears, D. 1996. First nesting of the Razorbill, *Alca torda*, in the Wolves Archipelago, New Brunswick. Canadian Field-Naturalist 110(4): 698-700; Mawhinney, K. and Diamond, A.W. 1999. Sex determination of Great Black-backed Gulls using morphometric characters. Journal of Field Ornithology 70(2): 206-210; Mawhinney, K. and Diamond, A.W. 1999. Using mark-recapture ratios of radio-transmitters to improve estimates of gull predation on eider ducklings. Condor 101(4): 824-831; Mawhinney, K. Diamond, A.W., Kehoe, P. and Benjamin, N. 1999. Status and productivity of Common Eiders in relation to the status of Great Black-backed Gulls and Herring Gulls in the southern Bay of Fundy and northern Gulf of Maine. Waterbirds. 22(2): 253-262. Mawhinney, K., A.W. Diamond and F.P.Kehoe. The use of energy reserves by Great Black-backed Gulls during breeding. Canadian Journal of Zoology 77: 1459-1464.

Non-biological or non-ecological factors: Not known.

How

Concerns, threats: Potential threat from oilspill in nearby shipping lane. Current level of fishing activity not known to be threat.

Are any of these threats cumulative?

Interested parties: Currently fished extensively; some ecotourism; no other uses identified.

Is this area already managed under a specific initiative or regulation? No.

Management recommendations: Increase awareness among users; monitor use by seabirds.

Site name: Whitehorse Island

Where: GIS reference: single coordinate, table of points, GIS referenced image to be scanned in. 44 59'N, 66 52'W

Is there an accompanying chart or image? Yes
Description of location: Small island 4.2 km east of Deer Island, 5 km NNE of East Quoddy Head (Campobello Island).
Approx. parameters: < 5 ha.
Marine structures: None
Land structures: None

Why

Only breeding site in the BOF of Northern Gannet (*Morus bassanus*), first nesting in 1999 since 1880; also a large colony of Double-crested Cormorant *(Phalacrocorax auritus*); newly colonized breeding site of Black-legged Kittiwakes *(Rissa tridactyla);* and possibly a new breeding site of Atlantic Puffins *(Fratercula arctica)*
Critical/significant habitat: terrestrial habitat critical for nesting; extent and locations of associated feeding areas unknown.
Single species importance: not for the nesting species, but as sole site in province for gannet, clearly it should be.
Biological/ecological characteristic: breeding area
Biodiversity: Could be provided
Visualization: colour photos of nesting birds available
Description: a very small offshore island crowded with nesting seabirds has become important target for ecotourism. Marine environment not described.
General References/Data available: one paper in press, describing gannet nesting, another on kittiwakes in review.
Corrigan, S. and Diamond, A.W. 2000. Northern Gannet, *Morus bassanus*, nesting on Whitehorse Island, New Brunswick. Canadian Field-Naturalist 115:176-177.
Non-biological or non-ecological factors: Not known.

How

Concerns, threats: Potential threat from oil spill in nearby shipping lane. Current level of fishing activity not known to be threat. Ecotourism activity increasing, may require regulation.
Are any of these threats cumulative?
Interested parties: Currently fished extensively; some ecotourism; no other uses identified.
Is this area already managed under a specific initiative or regulation? No
Management recommendations: Increase awareness among users; monitor use by seabirds.

Site name: North end of Grand Manan

Where: GIS reference: 44 48'N, 66 47'W
Is there an accompanying chart or image? Yes
Description of location: Up to 5 km north of northern end of Grand Manan Island.
Approx. parameters: ca. 10 sq km

Marine structures: several herring weirs
Land structures: none

Why

Major wintering area of a large proportion of North American population of Razorbills *(Alca torda)*
Critical/significant habitat: shallow water, much upwelling
Single species importance: Razorbill is species of regional concern
Biological/ecological characteristic: Wintering area.
Biodiversity: Draft manuscript exists
Visualization: None
Description: Description of marine area not found. Other species using area in winter: Common Eider *(Somateria mollissima)*, Thick-billed Murre *(Uria lomvia)*, Common Murre *(Uria aalge)*, Dovekie *(Alle alle)*.

General References/Data available: Draft manuscript: see also *Huettmann, F.* 1999. Discovery of a large proportion of wintering North American Razorbills *Alca torda* in the lower Bay of Fundy, Canada. Bird Conservation International 9:96
Non-biological or non-ecological factors: Not known

How

Concerns, threats: Potential threat from oil spill in nearby shipping lane. Current level of fishing activity not known to be threat. Proposed krill fishery a potential threat
Are any of these threats cumulative?
Interested parties: Currently fished extensively; no other uses identified.
Is this area already managed under a specific initiative or regulation? No
Management recommendations: Deny proposed krill fishery; increase awareness among users; monitor use by seabirds.

Site Name: Head Harbour Passage

Where: GIS reference: See Map.
Is there an accompanying chart or image? Yes
Description of location: From Western Passage along East Coast of Deer Island to Letite Passage.
Approx. parameters: Shallow water, much rockweed, vegetated offshore islands.
Marine structures: Many weirs & salmon farms.
Land structures: Many cottages; several villages.

Why

Major feeding area for large numbers of Red-necked Phalaropes (*Phalaropus lobanus*) and Bonaparte's Gulls (*Larus philadelphia*) in fall and early winter.

Critical/significant habitat: channels among islands, much upwelling provides rich feeding grounds.
Single species importance: Red-necked Phalaropes are species of concern due to the steep decline from unknown causes.
Biological/ecological characteristic: staging area during fall migration.
Biodiversity: could be provided
Description: small offshore islands, strong currents, rockweed beds

General References/Data available: several papers available
Non-biological or non-ecological factors: important for recreation and ecotourism, whale watching

How

Concerns, threats: Current level of fishing activity not known to be threat, but not adequately investigated. Ecotourism activity increasing, may require regulation. Rockweed harvesting, salmon farming, and increased recreational activities are potential threats.
Are any of these threats cumulative? Likely to be so
Interested parties: Currently fished extensively; much recreational use; some rockweed harvesting.
Is this area already managed under a specific initiative or regulation? No
Management recommendations: Increase awareness among users; monitor use by gulls and phalaropes; limit rockweed harvesting; restrict salmon farming to least sensitive sites.

Site name: Maces Bay, Pocologan Harbour

Where: GIS reference: 45 05'N, 66 25'W to 45 05'N 66 40'W.
Is there an accompanying chart or image? Yes
Description of location: From Point Lepreau west along coast to Red Head. Includes Salkeld Islands in Maces Bay and New River Island in Pocologan Harbour.
Approx. parameters: Shallow water, much rockweed.
Marine structures: Some weirs & salmon farms.
Land structures: Many cottages; also a nuclear power plant.

Why

Important nesting colonies of Common Eiders (*Somateria mollissima*) on Salkeld and New River islands; and important brood-rearing habitats (rockweed along mainland shore)

Critical/significant habitat; terrestrial habitat critical for nesting; extent and locations of associated feeding areas under investigation.
Single species importance: All Common Eider habitats need protection. Species not listed but of regional concern and is managed for hunting.
Biological/ecological characteristic: breeding area

Biodiversity: Could be provided
Visualization: Colour photos of islands available
Description: small offshore islands and rockweed beds along mainland coast

General References/Data available: data currently being gathered for MSc thesis, some can be shared by mutual agreement, will all become public once thesis is completed.
Non-biological or non-ecological factors: aesthetic importance of New River Beach Provincial Park; New River Island is a private nature reserve.

How

Concerns, threats: Current level of fishing activity not known to be threat. Ecotourism activity increasing, may require regulation. Rockweed harvesting and increased recreational activities are potential threats.
Are any of these threats cumulative? Could be!
Interested parties: Currently fished extensively; much recreational use; some rockweed harvesting
Is this area already managed under a specific initiative or regulation? No, except for New River Island (nature reserve).
Management recommendations: Increase awareness among users; monitor use by eiders; restrict rockweed harvesting.

Dr. Martin L.H. Thomas, Little Letite Passage, Musquash Head

Professor Emeritus, University of New Brunswick
Address/Email/Phone: RR4, Bridgetown, Nova Scotia B0S 1C0; 902-665-2054; harthomas@ns.sympatico.ca
Profession/area of expertise: Marine Ecologist

Site Name: Little Letite Passage

Where: nautical charts submitted
Description of location: Passage between Pendleton Island and McMaster Island in the Deer Island Archipelago.
Approx. parameters: 300m wide 500m long, 0-25m deep
Marine structures: No structures.
Land structures: One island - Little Ireland Island

Why

Critical/significant habitat: Very fast tidal currents of >100cm/sec at the bottom. Higher in water column. Very high percent cover of benthic organisms. Species listed in several publications and theses.
Single species importance: One new species of sponge described from here so far found nowhere else.

Biological/ecological characteristic: Unique assemblage of organisms adapted to feeding in extreme current conditions. Large aggregations of *Cucumaria frondosa*.
Biodiversity: Biodiversity extremely high. Several publications and a collection of underwater videotapes back this up.
Visualization: Yes
Description: as above
General References/Data available: *Probably* best summed up in Ginn (1997) M.Sc. Thesis UNBSJ.
Non-biological or non-ecological factors: Certainly used by First Nation's people in the part (artifacts and middens common in the area).

How

Concerns, threats: Could be easily damaged by shipping. Fast currents preclude most fishing.
Are any of these threats cumulative? No.
Interested parties: Has been UNBSJ research site. St. Andrews DFO have interests here.
Is this area already managed under a specific initiative or regulation? No.
Management recommendations (options, requirements): Should be a marine sanctuary. No fishing of any kind. No mooring. No shoreline development.

General Comments

This area is probably not unique but is the best researched of the Deer Island Archipelago passages. All the passages have very high biodiversity and similar species arrays. The whole Deer Island area has been considered for a marine park. Such a development could afford protection to all the passages. In the absence of wider protection, Little Letite Passage would be a logical choice for special protection as it is well studied, carries minimal boat traffic, has no present development and has good access.

Site Name: Musquash Head

Where: See standard charts and topographical maps.
Description of location: Musquash Head is well known. It has been suggested in the past for protection along with Musquash Harbour. Minimal useful protected area would be 1km E and 1km NW of the lighthouse.
Approx. parameters: Ideally the area should include the shoreline, cliffs and the coastal forest at least 500m inland of the high tide mark.
Marine structures: None at present but has been suggested as the site of a large wharf.
Land structures: Lighthouse and associated structures.

Why

Critical/significant habitat: This location is not unique but is the best remaining example of a lower Bay of Fundy rock headland on the New Brunswick shore. Point Lepreau was equally good or perhaps even better than Musquash Head but is now the site of a nuclear power plant. Cape Spencer is a poorer site altogether and has been the location of a gold mine

Single species importance: No single species importance but rather a typically rocky headland biological community.

Biological/ecological characteristic: This location has excellent intertidal communities of:

a) well drained exposed headland,
b) headland tidal pools,
c) semi-sheltered well drained rocky shores,
d) sheltered tidal pools, and
e) sandy beach community.

It also has very good supra-littoral and cliff face communities. The coastal forests show typical features of a forest exposed to marine influence.

Biodiversity: Typical of these headlands. Moderately high biodiversity. Species and zonation described in a number of publications. Specimens of biota at UNBSJ.

Visualization: Lots of 35mm slides are available.

Description: High rock cliffs and solid rock intertidal on the outer shore give way to low cliffs and rubbley shores moving into the bay with one large black sand beach just inside the headland.

General References/Data available: Several theses, scientific papers and reports from work at UNBSJ. These have all been listed in past attempts to preserve this area.

Non-biological or non-ecological factors: Area of great natural beauty. The associated Musquash Harbour and Salt Marsh are also worthy of protection and are well studied and documented. It is a possible area for expansion of Saint John port facilities.

How

Concerns, threats: Possible port development.

Are any of these threats cumulative? Not yet.

Interested parties: Headland has been used for research and teaching by UNBSJ for a long time (since Point Lepreau was developed).

Is this area already managed under a specific initiative or regulation? No.

Management recommendations (options, requirements): The protection of the headland is critical but the whole harbour and salt marsh complex associated with it should be considered too.

Dr. Peter W. Hicklin, Shepody Bay, Minas Basin

Canadian Wildlife Service, Atlantic Region, Wildlife Biologist (Coastal Birds)

Site Name: Shepody Bay intertidal mudflats and beaches; Southern Bight Minas Basin intertidal mudflats and beaches

GIS reference: A. Shepody Bay: 45°45'N 64°35'; B. Southern Bight, Minas Basin: 45°05'N64°20'W

Is there an accompanying chart or image? Any 1:500,000 topographic map of the Maritime Provinces shows both branches of the bay with the extent of intertidal mudflats at low tide.

Description of location: Two distinct embayments of the Bay of Fundy off the two main arms of the bay (Chignecto Bay and Minas Basin)

Approx. parameters: at low tide, about 30,000 ha2 of biologically rich mudflat requires legislated protection.

Marine structures: mainly wharves and rocky ledges near the low water mark.

Land structures: salt marshes and rocky beaches.

Why

Critical/significant habitat: critical as a foraging/roosting area for the world population of the Semipalmated Sandpiper during southward migration to the wintering grounds.

Single species importance: Of critical importance for the world population of Semipalmated Sandpipers.

Biological/ecological characteristic: Migratory stopover for the semiplamated Sandpiper.

Biodiversity: Brylinski et al. 1997. The biological environment in the Bay of Fundy *In* Percy, J.A., P.G. Wells and A.J. Evans (eds) (1997) Bay of Fundy Issues: a Scientific Overview. Workshop Proceedings, Wolfville, N.S., January 29 to February 1, 1996. Environment Canada – Atlantic Region Occasional Report no. 8, Environment Canada, Sackville, New Brunswick, 191 pp.

Visualization: Yes

Description: expansive mudflats and strong tidal currents.

General References/Data available: some of the data available via publications and consultations with Fundy working groups.

Non-biological or non-ecological factors: Yes, significant scientific and aesthetic importance.

How

Concerns, threats: The main threats consist of projected openings and closings of tidal barrages in many tidal rivers in the Bay of Fundy; barrages, such as the causeway between Riverview and Moncton, affect tidal currents. Permanent opening of these structures should be conducted gradually in order to minimize physical and biological impacts to the mudflats due to changing tidal currents and, consequently, the sedimentary regimes in the upper bay.

These threats are cumulative as there are many barrages across the rivers and each should be treated independently.

Interested parties: Yes, federal government departments such as Environment Canada and Dept. of Fisheries are interested because of potential negative impacts on birds and fish, and a number of universities in the Maritime provinces (e.g.: Universite de Moncton, Mount Allison, and Acadia University) conduct long-term research programs in the Bay of Fundy, particularly in the intertidal zone.

Is this area already managed under a specific initiative or regulation: Shepody Bay National Wildlife Area; Western Hemisphere Shorebird Reserves (two, in Chignecto Bay and Minas Basin) and Minas Basin has been named an important conservation area by the Dept. of Natural Resources in Nova Scotia.
Management recommendations: declare the intertidal zone of the Bay of Fundy as a Conservation Area protected by the federal and provincial governments of New Brunswick and Nova Scotia. Mary Majka, Mary's Point, Grindstone Island

Naturalist, educator, long-time resident of the area
New Brunswick Federation of Naturalists; Albert County Heritage Trust
Mary's Point Shorebird Reserve, 435 Mary's Point Road, Harvey on the Bay
Albert Co., N.B. E4H 2M9

Site name: Mary's Point/Grindstone Island area

Where: Map copies attached.
Description of location: This is a well-known area located in the upper Bay of Fundy. It is composed of an island (Grindstone Island) and a peninsula (Mary's Point) that become three islands on high spring tides, and the surrounding intertidal habitats. This area is approximately 7 km from the village of Riverside-Albert, N.B. and 10 km across the bay from Joggins, N.S.

Land structures: The site is not inhabited. The upper parts of the islands are covered with coastal forest. The lower parts are beaches, sand dunes and ledges connected with extensive mudflats and marshes.

This area has already been designated a Ramsar Site and a Western Hemisphere Shorebird Reserve. A portion of it is located within Shepody National Wildlife Area. The reason why this area should be considered is that its recognition by international bodies and provincial and federal governments does not translate into any legal obligation for protection (except for the small NWA).

Critical/significant habitat: Intertidal Mudflats These are very extensive and are of tremendous significance. They harbour a variety of invertebrates, which is the source of food for migrating shorebirds. Most of those mudflats apparently fall under provincial jurisdiction, whereas the intertidal shore of Grindstone Island belongs to the Anglican Church of Canada. Tidal Marshes There are many hectares of salt marshes, formerly dyked for agricultural use but now flooded by the sea. Of those only a very small portion is protected within the National Wildlife Area. Most could not be acquired because of lack of documentation of ownership. The privately owned marshes could easily be encroached before anybody realizes. Intertidal Ledges Stretching out from Mary's Point towards Grindstone Island and eastward from Long Point are ledges that harbour a great variety of marine life (molluscs, arthropods). They should be fully explored since they might be of significance, having a different environment from those in more sediment-free locations. Grindstone Island Most of the island is privately owned by the Anglican

Church of Canada and a small portion is federally owned and administered by the Canadian Coast Guard. There is a current proposal to abandon the light station.

Biological/ecological characteristic: Beyond the fact that there are some privately owned tourist interests which would like to use the island as an "ecotourism" destination, the island is occasionally visited by fishermen. The island has been recognized as having ecological significance because of its large colony of Great Blue Herons. It is also a breeding area for Double-crested Cormorant, Common Eider, Great Black-backed Gull and Herring Gull. For several years it was also the site of a Peregrine Falcon nest, but no nest was found in 2000, even though birds were still somewhere in the area. Because of the very moist habitat the vegetation on the island differs from that on the mainland and has been described by a botanist as worthy of further study. This short description of the flora and fauna does not really give full credit to the significance of the area.

Non-biological or non-ecological factors: Both Mary's Point and Grindstone Island were mentioned in early historical reports. They have been used by mariners, fishermen and natives as stopping and lookout points. In historic times, King George V granted Grindstone Island to the Church of England to be used as a source of revenue. It was also mentioned that a French fort was located on Mary's Point. Both Grindstone Island and Mary's Point became sites for quarrying stone. Grindstone Island became a light station in 1854 and remained so until now. It was automated in 1970. The light keepers who lived on the island left various accounts of their lives there, including some legends and stories of hardship.

Concerns, threats: There are environmental concerns about each of the above mentioned features. Mudflats have been damaged extensively in other parts of the Maritimes by extraction of bait worms for fishing. Recently, a recreational fad, mud sliding, has become popular, which could also be damaging if done extensively. Mud could also be mined for extraction of some unforeseen substances, such as medicinal mudpacks. Salt Marshes There is still great pressure from developers, highway engineers and private owners to drain, ditch or fill in marshes. In the area described, there is an extensive tract of marshes where questionable ownership should be resolved. A smaller but equally valuable marsh on the west side is in private hands and there an attempt was made to build a road (luckily stopped by CWS and NB-DOE). This marsh was also used as a local dumpsite for many years. Although now buried, it might still be leaching all sorts of lethal substances and therefore should be investigated. Ledges For the time being they are in the least danger; however, the silt carried from the opening of the Petitcodiac causeway might have some consequences. Those ledges should be investigated further and protected from beachcombers, curiosity seekers, etc. Grindstone Island Attempts have been made by the Canadian Wildlife Service and myself to secure the protection of the island. At one time the Anglican Church was contemplating lumbering the forest there! Some permanent arrangement, either acquisition, long-term lease, easement or other method, would be a valuable investment in the ecological integrity of this part of the Bay of Fundy.

Michael Griffin, Hazen Creek

Hazen Creek Tidal Marsh Restoration Project. Red Head Road, Saint John, NB.
This Marsh is approximately 10 sq km in area, excluding the watershed that feeds it. Ducks Unlimited has had it under lease for some 16 years or so. There is approximately 5 years left on the leases. Since the installation of the Ducks' water level control structure in 1984, the Hazen Marsh has suffered immensely. As there seems to be no decrease in the destruction of the watershed and the marsh in the last four years I feel I have no choice but to move on to more drastic measures and that is to submit this marsh and watershed to yourself for inclusion on the list of sites to be considered for Marine Protected Area Status.

This marsh lies in an industrialized area within 5 minutes of the downtown core. It is fronted by a large sand and gravel beach and armourstone dyke. I have recently discovered that the City of Saint John is moving to expand the Hazen Creek sewage treatment plant. This expansion will involve infilling portions of this marsh.
It is my hope that the survival of this marsh and watershed can be provided as a Marine Protected Area. In the meantime it would be helpful to have it listed as a potential site to ensure that the reckless infilling and development ceases until a determination of its status.

I would be pleased to tour the site with you and others to explain its past, present and future place in our ever decreasing inventory of unique tidal marsh habitat. This is a marsh that deserves to live!

Dr. Nathaniel T. Wheelwright, Kent Island

Professor of Biology, Director of the Bowdoin Scientific Station

Site name: Kent Island

Where: $44^{o}35'$N, $66^{o}46'$W
See www.academic.bowdoin.edu/kent_island
9 km S of Seal Cove, Grand Manan, NB; part of Three Islands archipelago
80 ha
Two unused weirs, 1 wharf, ledges all around
Marine lab, terrestrial ecology lab, dorm, boathouse, several residential buildings, outhouses

Why

Kent Island is a Sensitive Area, an island seabird breeding colony and one of last refuges of breeding Common Eiders in the Gulf of Maine in the 1930s when the species was close to local extinction; one of largest colonies of Leach's Storm-Petrels along the western shore of the Gulf of Maine; site of numerous rare vagrants (Sage Thrasher, Fork-tailed Flycatcher).

Part of recently designated Important Bird Area for Canada because it is the last staging area for tens of thousands of migratory shorebirds
200 bird species, 60 marine algal species, 280 plants species (see www.academic.bowdoin.edu/kent_island for species lists)
Strong currents of Bay of Fundy; deep water immediately offshore; 20-foot tide
See List of Publications of the Bowdoin Scientific Station
Settled in late 1700s; see Keith Ingersoll, Wings Over the Sea; Abenaki Indian artifacts found; scenic views, outermost island in Grand Manan Archipelago

How

Threats: rockweed harvesting, salmon aquaculture: disrupt long-term biological monitoring, environmental education; threaten food supply of migratory shorebirds
harmful combined effect of both
Biological field station, member of the Organization of Biological Field Stations (one of only two in the Canadian Maritimes), control site since 1970s for research on environmental contamination by Canadian Wildlife Service, used for research by individuals from leading Canadian and U.S. universities
Managed by Bowdoin College as a sanctuary since 1934 as part of Terms of Donation of Kent Island; not recognized by Province of New Brunswick
Kent Island should be designated an exclusion area for any aquaculture projects that threaten bird populations, long-term biological monitoring, environmental education

Dr. Michael Owen, Quoddy Region

Research Scientist, Dean of Graduate Studies
University of Western Ontario, London, Ontario

I write as a marine biological educator with 29 years experience of teaching, diving and sampling in the Passamaquoddy Bay and Fundy Isles area. I, like many others, have heard talk, in the last decade or so, of the possibility of the establishment of a Marine National Park (some time ago), and more recently of a Marine Protected Area to address concerns for the biological, and closely associated economic, survival of the area.

I look back to the early '70s when a drag sample, or a dive, in the upper region of Passamaquoddy Bay (e.g. Joe's Point or Tongue Shoal) revealed a species diversity that can now be found in only very restricted parts of the Deer Island – Campobello area. This dramatic reduction in faunal diversity across the area must be attributed, in large part, to the impact of those fisheries that tow gear across the substratum (in particular the scallop fishery). More subtle, and perhaps natural, ecological factors may also have been involved. While unfortunate and a matter for concern, I have viewed this situation as one of the inevitable trade offs in managing the balances between economic pressure and necessity and maintenance of environmental condition. It has been possible to take such a view while refugia, in which stable communities that show a full faunal diversity, have survived in good condition. Such refugia have indeed been present on the rock ledges and walls of the near-shore islands. These sites are not accessible to drags and are affected in only minor ways by the well-regulated, and historically successful, lobster fishery. Recent developments (rockweed harvesting, aquaculture) threaten their ecological balance and hence their survival.

"Conservationists are far from able to assist all species under threat, if only for lack of funding. This places a premium on priorities: how can we support the most species at the least cost? One way is to identify 'biodiversity hotspots' where exceptional concentrations of endemic species are undergoing exceptional loss of habitat." [Biodiversity Hotspots for Conservation Priorities. Norman Myers, Russell A. Mittermeier, Cristina G. Mittermeier, Gistava A.B. da Fonseca and Jennifer Kent. Nature, 403 (24 Feb, 2000) 853-858]

A further demonstration of the importance of maintenance of local refugia as sources for recolonization of an area is summarized in the work of Cowen *et al.* [Connectivity of Marine Populations: Open or Closed? Cowen, Robert K., Lwiza, Kamazima M.M., Sponaugle, Su, Paris, Claire B. and Olson, Donald B. Science 287: 857-859, 4th Feb. 2000] on the dispersal of larval stages. Assumptions of long distance transport of larvae were shown to be nine orders of magnitude too high and, I quote, "…larval retention near local populations is shown to exist and may be of great importance in the maintenance of marine population structure and management of coastal marine resources."

Chief Hugh Akagi - The Passamaquoddy Perspective, Ship's Harbour

Site name: Ship's Harbour

History has shown that for thousands of years my people enjoyed the islands bordering Passamaquoddy Bay for many reasons, hunting, fishing, gathering, as well as feasting, and religious ceremonies. One of the most beautiful of these islands is now known as McMaster Island and one of the most tranquil settings is what has become known as Ships Cove. The importance of preserving these links to our past has not been lost and it is becoming ever more critical that we stop the bleeding of my people by maintaining the pristine portions of our history to which we must link to preserve our culture and heritage. It is becoming more and more difficult to show our children how their ancestors lived, when the changes occurring daily tend to rob us of our culture. How can we tell them how their ancestors walked among these islands enjoying their existence in such a beautiful world surrounded by open waters, peaceful bays, crying eagles; when they must look at cagesites and industry which can only deepen the loss of that which was once ours and ours alone (yet for all to enjoy). The memories will not be of Natives children playing on the beaches while the adults prepared their catch; but rather how the fish that were once plentiful, are no longer there (hence we must resort to farming them). Because of a sister industry, agriculture, the call of the eagle was lost to these islands for what was nearly, forever. These are not the teachings we must restore to our communities. As we struggle to recover our past it is becoming ever so vital that places such as Ships Cove and McMaster Island be spared as these are some of the few places left where my people may return to their roots in a peaceful setting on their own land. To this day, the Cove is where my people recover eagle feathers (after the moulting season) so necessary to our culture and traditions. I fear that industry in this area would disturb this as a resting place for these eagles. We need tranquil areas to appreciate and experience what is around us; we need not lose what we already have.

In my own oral history, are recounting of stories where my great uncle, Wallace Nicholas, hunted porpoise and fished along these islands, cleaning his catch on these very beaches for which we are asking for protection. This was told to me by the son of the lighthouse keeper at Green's Point across from Ships Cove. As a ten-year-old boy, he would visit this Indian who would tell him stories while cooking and drying his catch. I have visited a midden in back of Ships Cove where my people obviously enjoyed many a meal of clams while pursuing their daily lives. Development destroys history. The Islands are already being logged; beaches used for industry of every kind (aquaculture, seaweed harvesting and clam digging), the waters dragged mercilessly to yield fish, scallop, and urchins. When will someone have the backbone to say enough is enough! Who will stand and declare that we need not sacrifice all to the almighty dollar? How can we prevent people from putting a price on our history? Though a few tend to make money on these ventures, when something is lost, we all pay the price!

I would ask that all who can, do their share to assure the native way of life is preserved, not lost; valued, not denied; enjoyed, not destroyed. The native way of life is important to all, not just Natives. We believe we are part of the Earth (hence the term Mother Earth), and we do not want anything to happen to her. For it was our mother that gave us life and nurtured us through the years, and the least we can do is look after her before it is too late. Is there one among you who would tolerate the rape of their mother? As a Native I believe aquaculture is guilty of raping my mother Earth and I can prove it! When rape occurs, it is the attempt to force a relationship, the end result of which is reproduction where none was wanted. Our mother Earth has produced for us from her very bosom, yet we were not satisfied with what she gave (natural harvest). So in our greed we found ways to produce more and we swell her belly with nets from aquaculture sites. She is being forced to carry the babies she did not want. She will be forced to care for them as she fills with the waste they create, a poison to her system. Eventually, she must feed that poison to her very children for she will have no choice (Walkerton, Ontario). Is this not rape? Has she not been violated?

As the world expounds equality, awareness, and rights, let's give these words true meaning (not the proverbial lip service). I am asking that you help secure this area that it might survive as it has done for thousands of years and in so doing, help my people survive as they have done for thousands of years.

Woliwon, Hugh M. Akagi (Chief of Passamaquoddy Peoples).

Dr. Gordon B.J. Fader, Brown's Morraine, NE Channel, Mussel bioherms

Marine Geologist, Geological Survey of Canada (Atlantic), Bedford Institute of Oceanography.

Getting to you question on MPAs in the area, we only have multibeam over a number of small areas where we hygraded the collection and the big Georges, German and Browns surveys. The old maps are not good enough to characterize the seabed for such a designation. I have an extended abstract in progress on this issue, as part of the habitat review at BIO last June. Where we have multibeam we do not have detailed biological sampling. However, based on what we have, the Browns Bank moraine should be part of an MPA, the mussel bed areas of Fundy where I am working with Wildish, a few inner areas where thin gravel overlie thick mud in a constant state of erosion, part of Northeast Channel to protect the coral which is now known, etc.

I - MAPPING WORKSPACES CREATED

November, 2002

Folder: ACCDC-Arcad

AvifaunaACCDC.WOR
Location of avifauna recorded within 5 km of Bay of Fundy shores (several references, see Gerriets, 1997-2001)
Data type: Excel data file

BirdMapACCDC.WOR
Areas with some form of protection are shown as yellow squares or polygons. A 5 km buffer around the study area is marked with a heavy red circle. Avifauna occurrences are shown as magenta triangles. Seabird colony locations are show as open magenta circles
Data type: BMP Image file

ProtectedAreasACCDC.WOR
Locations of protected and managed areas within 5 km of the Bay of Fundy shoreline (ARCAD, ACCDC data)
Data type: Excel data file

SeaBirdColoniesACCDC.WOR
Seabird colonies within 5 km of Bay of Fundy shores (Amirault, 1997-2000; Gerrie, 1997-2001)
Data type: Excel data file

Folder: Aquaculture sites

ProvMapExclAreas.WOR
New Brunswick Department of Agriculture, Fisheries and Aquaculture map of Aquaculture Bay Management Areas showing controlled growth and exclusion areas (October 2000). Traced from scanned map
Data type: MapInfo TAB files

BBLI-AquaSites2001ProvMap.WOR
Location of aquaculture sites in Back Bay - Letang Inlet area

BofFAquaSitesCCRM99.WOR
Location of Aquaculture Sites (Community Coastal Resource Mapping, 1999).
Data type: MapInfo TAB files

AquaSites2001ProvMap.WOR

Location of aquaculture sites as of June 2001 (B. Chang, per. com.). Also showing controlled growth and exclusion areas
Data type: Excel data and MapInfo TAB file

Folder: Ascophyllum

NBHarvestSitesAsco.WOR
Figure F1. Deadmans Head to Lorneville Harbour: Ascophyllum harvestable crop sectors (4-1 to 4-4, 5-1 to 5-10) and study areas (S-5, S-6, S-7, S-8) (Source: B. Semple)
Data type: MapInfo TAB files

NBHarvestSitesAscoBoF.WOR
Ascophyllum harvesting and study areas on map 4003 – Bay of Fundy
Data type: MapInfo TAB files

NBMeanAscoWeight.WOR
Mean Ascophyllum wet weight at sites sampled during 1989-90 (source: B. Semple)
Data type: Excel data and MapInfo TAB file

NBStudySitesAsco.WOR
New Brunswick Ascophyllum Study Sites (source: B. Semple)
Data type: MapInfo TAB file

Folder: BackBay-LetangInlet

BB-Letang.WOR
Contains the layers (box, coloured land and water areas) used in the MacKay number of species plot
Data type: MapInfo TAB files

BB-LI-McKNoSpp.WOR
Back Bay - Letang Inlet: Number of species recorded by MacKay et al. (1978) during spot examinations.
Data type: Excel data file

BBLI-McKAbundRating.WOR
Back Bay - Letang Inlet: Number of species recorded by MacKay et al. (1978) during spot examinations and polygons showing locations of high diversity/abundance rating

BBLI-DulseHarvAreas.WOR
Dulse harvesting areas (CCRM, 1999)
Data type: MapInfo TAB file

BB-LIScallopBedsCCRM.WOR
Scallop beds (CCRM, 1999)
Data type: MapInfo TAB file

BB-LISoftShellClamBeds.WOR
Soft-shelled clam beds (CCRM, 1999)
Data type: MapInfo TAB file

BB-LIShoreLineClass.WOR
Shoreline Classification (CCRM, 1999)
Data type: MapInfo TAB file

BB-LetangFishWeirs.WOR
Fishing weir positions (CCRM, 1999)
Data type: MapInfo TAB file

BBLI-SeaCukeFishEffort2002.WOR
Sea Cucumber 2000 Fishing Effort (M. Lundy, per. com., 2002)
Data type: Excel

Folder: BayofFundy-HagueLine

GOMBoundary.WOR
Oceanic boundaries of the Gulf of Maine as delineated by the Gulf of Maine Council on the Marine Environment.
Data type: MapInfo TAB file drawn by eye

Other workspaces here include:
GOMmapSmall.WOR
GOMmapLarge1.WOR
GOMmapLarge.WOR
hagueline.WOR: The hague line

Folder: BrierIsland

BrierIsland.WOR
Brier Island: Natural area of Canadian significance: Number of species recorded by MacKay (1977)
Data type: MapInfo TAB file drawn by eye

BrierIslandNoSpp.WOR
Brier Island: Natural area of Canadian significance: Number of species recorded by MacKay (1977)
Data type: Excel data and MapInfo TAB files
Data type: MapInfo TAB file

BrierIsAscoHarvestingAreas.WOR
Ascophyllum harvesting sectors (F1-F7) (Source: B. Semple, pers. com.)
Data type: MapInfo TAB file

BI-DigbyAqua&HerringWeirs.WOR
Locations of aquaculture sites (B. Chang per. com.) and herring weirs (CCRM, 1999)

BI-DigbySealHaulouts.WOR
Sea haulout locations (CCRM, 1999)
Data type: MapInfo TAB file

BI-WhaleSightings.WOR
General area of whale observations for the Brier Island area from 1985-1998 (Appendix III in Stephenson et al., 1999). *(From the report, see Table in BoF Text)*
Data type: MapInfo TAB file drawn by eye

Folder: Ccg-ecw

HerringAreasMusquash.WOR
Herring and Herring shut-off locations in the Lower Bay of Fundy area (CCRM, 1999).

WholeBofFDepthContour.WOR
Bay of Fundy: Depth Contour in metres (Community Coastal Resource Mapping, 1999).
Data type: MapInfo TAB file

WholeBofFHerring.WOR
Bay of Fundy: Location of herring and herring shut-off (Community Coastal Resource Mapping, 1999)
Data type: MapInfo TAB file

WholeBofFLobsSpawn.WOR
Bay of Fundy: Location of Lobster Spawning Areas (Community Coastal Resource Mapping, 1999)
Data type: MapInfo TAB file

UpperBoF-LobsterSpawning.WOR
Lobster spawning areas in the Upper Bay of Fundy (CCRM, 1999)
Data type: MapInfo TAB file

UpperBoF-Herring&Shut-off.WOR
Herring areas in the Upper Bay of Fundy (CCRM, 1999)
Data type: MapInfo TAB file

Musq-LornevilleHerring&Shut-off.WOR
Herring and Herring shut-off locations in the Musquash-Lorneville area (CCRM, 1999)
Data type: MapInfo TAB file

Folder: CommResMapping

GM-SeaUrchins.WOR
Sea urchin areas around Grand Manan (CCRM, 1999)
Data type: MapInfo TAB file

BB-Letang-SeaUrchins.WOR
Sea urchin areas around Back Bay-Letang Inlet (CCRM, 1999)
Data type: MapInfo TAB file

MacesBay-SeaUrchins.WOR
Sea urchin areas in the Maces Bay area (CCRM, 1999)
Data type: MapInfo TAB file

MinasChannel-SeaUrchins.WOR
Sea urchin areas in the Minas Channel area (CCRM, 1999)
Data type: MapInfo TAB file

DI-Campo-SeaUrchins.WOR
Sea urchin areas around DI-Campobello (CCRM, 1999)
Data type: MapInfo TAB file

PassStCroix-SeaUrchins.WOR
Sea urchin areas in the Passamaquoddy Bay - St. Croix Estuary area (CCRM, 1999)
Data type: MapInfo TAB file

PPPL-DusleHarvestingAreas.WOR
Dulse distribution n the Pea Point to Point Lepreau area (CCRM, 1999)

StMarysBay-SeaUrchins.WOR
Sea urchin areas in the area (CCRM, 1999)
Data type: MapInfo TAB file

Digby-SeaUrchins.WOR
Sea urchin areas in the Digby area (CCRM, 1999)
Data type: MapInfo TAB file

PtLep-SJHbr-SeaUrchins.WOR
Sea urchin areas in Pt. Lepreau-Saint John Harbour area (CCRM, 1999)
Data type: MapInfo TAB file

Folder: DeepSeaCorals

COHPS-DeepSeaMPA.WOR
This workspace contains all the layers about this area - shows boundaries and distribution of deep-sea corals. Proposed Deep Sea Coral MPA in the Georges Bank-Northeast Channel-Browns Bank area (COHPS Web site: cohps.atlantisforce.org/)
Data type: MapInfo TAB file drawn by eye

HellHole&RomeysPeak.WOR
Shows boundaries and names of the features in the proposed MPA for deep sea corals.
Data type: MapInfo TAB file

Folder: DeerIs-Campobello

MapDIsCampIs.WOR
Base layers for the workspace containing: Number of species (flora and fauna) recorded by MacKay et al. (1978)
Data type: Excel data and MapInfo TAB file

MckNoSppDIsCampIs.WOR
Number of species (flora and fauna) recorded by MacKay et al. (1978)
Data type: Excel data and MapInfo TAB file

DIsC-SeaCukeFishEffort2002.WOR
Sea Cucumber 2000 Fishing Effort (M. Lundy, per. com., 2002)
Data type: Excel

DIsCampIs-AscoHarvestingAreas.WOR
Figure A2. Ascophyllum harvesting sectors and study areas (Source: B. Semple)
Data type: MapInfo TAB files

DIsCampLawton93LobsDistri.WOR
Figure A5. Relative abundance of lobsters from transects and collection dives (Lawton, 1993)
Data type: MapInfo TAB file done by eye

DI-CampFishingWeirs.WOR
Location of fishing weirs (CCRM, 1999)
Data type: MapInfo TAB file

DI-CampIsShoreClass.WOR
Shoreline classification (CCRM, 1999)
Data type: MapInfo TAB file

DI-CampHbrPorpoiseGaskin&Smith.WOR
Areas of sightings of mother-calf pairs of harbour porpoise (*Phocoena phocoena*) 1970-1979 (Gaskin and Smith, 1979)
Done by eye
No data: MapInfo layer

DI-CampFinbackTracksGaskin&Smith.WOR
Finback whale tracks 1978, 1979 (Gaskin and Smith, 1979)
Done by eye

No data: MapInfo layer

DI-CampSealHaulouts.WOR
Sea haulout locations (CCRM, 1999)
Data type: MapInfo TAB file

DI-CampScallopBedsCCRM.WOR
Scallop beds (CCRM, 1999)
Data type: MapInfo TAB file

DI-CampSofShellClamBeds.WOR
Soft-shelled clam beds (CCRM, 1999)
Data type: MapInfo TAB file

Folder: Derek's Files

ProtectedAreasOwners.WOR
This indicates the protected areas and are labelled with Owners
Data type: DBF and Excel files

ProtectedAreasHectares.WOR
This is a thematic of protected areas in terms of hectares. Increasing blue circles
Data type: DBF, Excel files and MapInfo files

ProtectedAreasBoFundyOnly.WOR
Locations of protected areas around the Bay of Fundy. See Table 2 for details (Source: ARCAD/DFO database)
Data type: DBF, Excel files and MapInfo files

Folder: Digby-Annapolis

DigbyAnna-ScallopBeds.WOR
Scallop beds (CCRM, 1999)
Data type: MapInfo TAB file

Digby-AnnaSoftShellClam.WOR
Soft-shelled clam beds (CCRM, 1999)
Data type: MapInfo TAB file

Digby-AnnaScallop&SSClam.WOR
Scallop and Soft-shelled clam beds (CCRM, 1999)
Data type: MapInfo TAB file

Folder: FishLarval&Spawning

AtlanticCod4X-MFD.WOR

Numbers of Atlantic cod obtained in summer groundfish surveys in 1975-2000 (MFD Web-based data)
Data type: Excel extracted from MFD website

AtlanticCod4X-MFDCropped.WOR
Numbers of Atlantic cod obtained in summer groundfish surveys in 1975-2000 (MFD Web-based data)
Cropped to the line used in separating BoF from Scotian Shelf

AtlCod2000-4X-MFD.WOR
Numbers of Atlantic Cod obtained in summer groundfish surveys in 2000 (MFD Web-based data)
Data type: Excel extracted from MFD website

AtlCod95-00-4X-MFD.WOR
Numbers of Atlantic Cod obtained in summer groundfish surveys in 1995-2000 (MFD Web-based data)
Data type: Excel extracted from MFD website

Cod4XStage4-81-93.WOR
Stage 4 Cod locations determined from Sawtooth Bongo Tows - fall 1981-1993 (Hanke et al., 2000). *(Areas determined and summarized from the report)*
Data type: MapInfo TAB file drawn by eye

CodLarval&SpawningAreas.WOR
Cod spawning and larval areas (Hanke et al., 2000). *(Areas determined and summarized from the report)*
Data type: MapInfo TAB file drawn by eye

CodStage1EggsHanke00.WOR
Location of Stage 1 Cod eggs (Hanke et al., 2000)
Data type: MapInfo TAB file drawn by eye

Haddock2000-4X-MFD.WOR
Numbers of Haddock obtained in summer groundfish surveys in 2000 (MFD Web-based data)
Data type: Excel extracted from MFD website

Haddock4X-MFD.WOR
Numbers of Haddock obtained in summer groundfish surveys in 1975-2000 (MFD Web-based data)
Data type: Excel extracted from MFD website

Haddock95-00-4X-MFD.WOR
Numbers of Haddock obtained in summer groundfish surveys in 1995-2000 (MFD Web-based data)

Data type: Excel extracted from MFD website

HerringLarvalDistStephenson.WOR
General area of distribution of herring larvae from the November 1995-1998 Bay of Fundy larval surveys (Stephenson et al., 1999)
Data type: MapInfo TAB file drawn by eye

HerringSpawningStephenson.WOR
Locations of known herring spawning current (solid) and historical (open) spawning locations in the Bay of Fundy - Georges Bank area (Stephenson el al., 1999)
Data type: MapInfo TAB file drawn by eye

Lobster4X-MFD.WOR
Number of lobster obtained in summer groundfish surveys in 1975-2000 (MFD Web-based data)
Data type: Excel extracted from MFD website

MacKenzie1934High#CodEggs.WOR
Locations of high numbers (>75) of cod eggs from surveys in 1932 (MacKenzie, 1934)
Data type: MapInfo TAB file drawn by eye from scanned map

MarAprStage1EggsHanke00.WOR
Presence of Stage 1 eggs March-April (Hanke et al., 2000).
Data type: MapInfo TAB file drawn by eye

NovDecStage1EggsHanke00.WOR
Presence of Stage 1 eggs November-December (Hanke et al., 2000)
Data type: MapInfo TAB file drawn by eye

Pollock2000-4X-MFD.WOR
Numbers of Pollock obtained in summer groundfish surveys in 2000 (MFD Web-based data)
Data type: Excel extracted from MFD website

Pollock4X-MFD.WOR
Numbers of Pollock obtained in summer groundfish surveys in 1975-2000 (MFD Web-based data)
Data type: Excel extracted from MFD website

Pollock4XStage1-81-93.WOR
Pollock egg stage 1 Sawtooth Bongo Tows Fall 1981-1993 *(Areas determined and summarized from MFD data summaries)*
Data type: MapInfo TAB file drawn by eye

Pollock95-00-4X-MFD.WOR

Numbers of Pollock obtained in summer groundfish surveys in 1995-2000 (MFD Web-based data)

PollockSpawningNOAArep.WOR
Pollock spawning areas by density (number of spawning individuals per m^2) (Cargnelli, 1999)
Data type: MapInfo TAB file drawn by eye from scanned map

Scott83AllFloundersBound.WOR
Research surveys 1970-81distribution of flounder species (Scott, 1983)
Data type: MapInfo TAB file drawn by eye

Scott83AmerPlaiceRipe&Spawing.WOR
Research surveys 1970-81 American Plaice distribution - ripe and spawning females (Scott, 1983)
Data type: MapInfo TAB file drawn by eye

Scott83Cod-ripe&Spawing.WOR
Research surveys 1970-81 Cod distribution - ripe and spawning females (Scott, 1983)
Data type: MapInfo TAB file drawn by eye

Scott83HaddockRipe&Spawing.WOR
Research surveys 1970-81 Haddock distribution - ripe and spawning females (Scott, 1983)
Data type: MapInfo TAB file drawn by eye

Scott83WinterFlounderRipe&Spawn.WOR
Research surveys 1970-81 Winter Flounder distribution - ripe and spawning females (Scott, 1983)
Data type: MapInfo TAB file drawn by eye

Scott83Witch&WinFlounderR-Spawn.WOR
Research surveys 1970-81 Witch & Winter flounders distribution - ripe and spawning females (Scott, 1983)
Data type: MapInfo TAB file drawn by eye

Scott83WitchFlounderRipe&Spawn.WOR
Research surveys 1970-81 Witch Flounder distribution - ripe and spawning females (Scott, 1983)
Data type: MapInfo TAB file drawn by eye

Scott83Y-tailFlounderRipe&Spawing.WOR
Research surveys 1970-81 Yellowtail Flounder distribution - ripe and spawning females (Scott, 1983)
Data type: MapInfo TAB file drawn by eye

SpawingAreas-Coon98.WOR
Figure C1. Spawning grounds in the lower Bay of Fundy (Coon, 1998).
Data type: MapInfo TAB file drawn by eye

Folder: FNP BiosphereReserve

BiosphereReserve.WOR
The boundaries of the proposed UNESCO Biosphere Reserve (Eberhardt, 2001)(traced from scanned map)

Folder: FundyIsles

FundyIslesSignifSites.WOR
Figure 2b. Natural areas of Canadian significance (Parks Canada/Tourism NB, 1985), MCBI proposed MPA (MCBI Website), and significant sites (numbered, various References, see Table 1
Data type: MapInfo TAB file drawn by eye

FundyIslesAquaSites.WOR
Figure A4. Location of aquaculture sites in the Fundy Isles area (CCRM, 1999).
Data type: MapInfo TAB file

FundyIslesFishingWeirs.WOR
Fundy Isles: Location of fishing weirs (CCRM, 1999)
Data type: MapInfo TAB file

Folder: FundyNationalPark

FundyNatPark-joined.WOR
Fundy National Park boundaries (Parks Canada) - open region - not shaded
Data type: MapInfo TAB file supplied by FNP

FundyNatPark.WOR
Fundy National Park boundaries (Parks Canada) - indicates two solid shaded regions
Data type: MapInfo TAB file supplied by FNP

Folder: Geology

Geology.WOR
Geological map of Bay of Fundy - Gulf of Maine
Data type: MapInfo TAB traced from Image File

Folder: Grand Manan

CampbellLobsMigration.WOR

General area of round-trip migration of ovigerous female lobsters from the shallow areas near Grand Manan to the deep waters of Grand Manan Basin (Campbell, 1986).
Data type: MapInfo TAB file drawn by eye

GM-AquaExclBMgtAreas.WOR
Aquaculture Bay Management Areas and Exclusion Zones (shaded) October 2000.
Data type: MapInfo TAB file drawn by eye from scanned map

GM-AscoHarvestingAreas.WOR
Figure B12. Grand Manan: Ascophyllum harvesting sectors (Source: B. Semple, pers. com.)
Data type: MapInfo TAB file drawn by eye

GMBerriedLobsArea.WOR
Areas of aggregations of berried lobsters during the summer. The highest numbers were recorded in Area A: Flagg Cove (Campbell, 1990)
Data type: MapInfo TAB file drawn by eye

GM-ClosedScallopProdArea.WOR
Closed scallop production area: closed during January scalloping season (DFO, 2001)
Data type: Data from DFO converted to Excel and MapInfo TAB file

GM-DulseHarvCCRM.WOR
Dulse areas around Grand Manan (CRRM, 1999)
Data type: MapInfo TAB file

GM-FishingWeirs.WOR
Location of fishing weirs in the Grand Manan area (CCRM, 1999)
Data type: MapInfo TAB file

GM-ECWShoreClass.WOR
Shoreline classification (CCRM, 1999)
Data type: MapInfo TAB file

GMKenNoSpongesBycatch.WOR
Number of species caught as bycatch in scallop drags in the Grand Manan area (Kenchington et al., 1999)
Data type: Excel data file

GMKenNoSppBycatch.WOR
Number of species caught as bycatch in scallop drags in the Grand Manan area (Kenchington et al., 1999)
Data type: Excel data file

GMKenNoSppMap4340.WOR

Number of species caught as bycatch in scallop drags in the Grand Manan area (Kenchington et al., 1999)
(on close up map of Grand Manan)
Data type: Excel data file

GMKenTunicatesBycatch.WOR
Locations of tunicates caught as bycatch in scallop drags in the Grand Manan area (Kenchington et al., 1999)
Data type: Excel data file

GMLawtonLobsters.WOR
Number of lobster (per hour = red on yellow) collected in random dives and found along transects (per 50 m2 = black on blue) in the Grand Manan area (1989-1992). Only areas outside Flagg Cove and Seal Cove plotted (Lawton and Robichaud, unpubl.)
Data type: Excel data file

GMLawton93LobsDistri.WOR
Relative abundance of lobsters in areas surveyed by Lawton (1993).
Data type: MapInfo TAB file drawn by eye

GM-LobsterSpawingCCRM.WOR
Lobster spawning areas (CCRM, 1999)
Data type: MapInfo TAB file

GMMcKNoSpp.WOR
Number of species (flora and fauna) recorded during 47 subtidal and 26 intertidal spot examinations and 9 transects (MacKay et al., 1979)
Data type: Excel data file.

Gm-mpa.wor
Relative abundance of lobsters (Lawton, 1993) (H = high, L = low, M = medium); Red numbers and regions = Bay Management Areas; Aquaculture sites = small boxes; Blue striped region = areas used by lobsters during migration; stars = fishing weirs
Data type: Excel data and MapInfo TAB files

GM-PlaceNames.WOR
Names of places around the Grand Manan area

GM-ScallopBedsCCRM.WOR
Scallop beds (CCRM, 1999)
Data type: MapInfo TAB file

GMSealHaulouts.WOR
Sea haulout locations (CCRM, 1999)
Data type: MapInfo TAB file

GM-ECWShoreClass.WOR
Shoreline classification (CCRM, 1999)

GM-SoftShellClamBeds.WOR
Soft-shelled clam beds (CCRM, 1999)
Data type: MapInfo TAB file

GM-SpawingAreas-Coon98.WOR
Figure B10. Spawning areas around Grand Manan (Coon, 1998)
Data type: MapInfo TAB file drawn by eye

Sub-folder: lob MPA

GM MPas.WOR
Layers for Lobster density, Lobster breeding areas, Fishing weirs, Aquaculture, Lobster Migration, etc.
Data type: Excel data and MapInfo TAB files

Folder: Hicklin&SmithAvifauna

Hicklin&Smith84Shorebirds.WOR
Areas of importance to coastal shorebirds in the Bay of Fundy (Hicklin and Smith, 1984)
Data type: MapInfo TAB file drawn by eye

Hicklin&Smith84Waterfowl.WOR
Areas of importance to waterfowl in the Bay of Fundy (Hicklin and Smith, 1984)
Data type: MapInfo TAB file drawn by eye

Folder: Hunter&Assoc

SigAvifaunaAreas.WOR
Significant avifauna areas (Hunter and Associates, 1982). Drawn by eye from page 166.
Data type: MapInfo TAB file drawn by eye

Folder: IBA-websiteData

IBA-WebData.WOR
Important Bird Areas in the Bay of Fundy as listed on the IBA web site. Includes several sites around the Bay of Fundy: Shepody Bay, Upper Cumberland Basin, Quaco Bay, Manawagonish Island, Saint Rest's Marsh and Beach, Maces Bay - Point Lepreau, The Wolves, Quoddy Region, Grand Manan Archipelago, Machais Seal Island, Brier Island and Offshore, Spencers Island/Cape d'Or, Southern Blight-Minas Basin, Cobequid Bay
Data type: MapInfo TAB file drawn by eye

MinasB-IBAWebData.WOR
Important Bird Areas in the Minas Basin area as listed on the IBA web site

Folder: JenniferGraham's

JuvenileHaddock.WOR
Juvenile Haddock habitat Pre 1970 and Post 1995 (Graham et al., 2002)

SpawningHaddock.WOR
Spawning Haddock areas Pre 1970 and Post 1995 (Graham et al., 2002)

Folder: Kenchington's Work

KenNoSpongeSppDigby.WOR
Number of sponge species caught as bycatch in scallop drags in the Digby area (Kenchington et al., 1999)
Data type: Excel data file

KenNoSppBycatch.WOR
Number of species caught as bycatch in scallop drags (Kenchington et al., 1999)
Data type: Excel data file

KenNoSppBycatchBI-Trinity.WOR
Figure C12. Number of species caught as bycatch in scallop drags in areas near Brier Island and Trinity Ledge (Kenchington et al., 1999)
Data type: Excel data file

KenNoSppEpibiotaDigby.WOR
Number of species caught as epibiota on scallop shells in scallop drags in the Digby area (Kenchington et al., 1999)
Data type: Excel data file

KenSpongesBycatch.WOR
Number of sponge species caught as bycatch in scallop drags (Kenchington et al., 1999)
Data type: Excel data file

KenSpongesBycatchBi-Trinity.WOR
Figure C14. Number of sponge species caught as bycatch in scallop drags in areas near Brier Island and Trinity Ledge (Kenchington et al., 1999)
Data type: Excel data file

KenTunicatesBycatch.WOR
Locations of tunicates (two species) caught as bycatch in scallop drags (Kenchington et al., 1999)
Data type: Excel data file

KenGM-Tunicates&Sponges.WOR

Locations of tunicates (two species) and sponges caught as bycatch in scallop drags (Kenchington et al., 1999)
Data type: Excel data file

Folder: Lawton&others1995

Lobster1995Annapolis.WOR
Number of lobsters collected on transect and collection dives in Annapolis Basin, September 1993, in grid areas (Lawton et al. 1995)
Data type: Excel data file

Lobster1995AnnapolisMigrat.WOR
Fall migration of lobsters out of the Annapolis Basin (Lawton et al. 1995)
Data type: MapInfo TAB file drawn by eye

Folder: Lawton&Robichaud97

Lawton&RobiLobsMig.WOR
Seasonal movements of lobsters during the summer and fall/winter from marking area (in red) near St. Martins (Lawton and Robichaud, 1997)
Data type: MapInfo TAB file drawn by eye

Folder: Lawton1993Lobsters

LawtonLobster1993.WOR
Relative lobster abundance determined by transects and collection dives (Lawton, 1993): Quoddy Region up to Point Lepreau
Data type: MapInfo TAB file drawn by eye

LawtonLobster1993BBay-LInlet.WOR *(Back Bay -Letang Inlet)*
Relative lobster abundance determined by transects and collection dives (Lawton, 1993)
Data type: MapInfo TAB file drawn by eye

LawtonLobster1993Beaver-Seely.WOR *(Beaver Harbour to Seeleys Cove)*
Relative lobster abundance determined by transects and collection dives (Lawton, 1993)
Data type: MapInfo TAB file drawn by eye

LawtonLobster1993DI-Campo.WOR *(Deer Island - Campobello)*
Relative lobster abundance determined by transects and collection dives (Lawton, 1993)
Data type: MapInfo TAB file drawn by eye

LawtonLobster1993MacesBay.WOR *(Maces Bay area)*
Relative lobster abundance determined by transects and collection dives (Lawton, 1993)
Data type: MapInfo TAB file drawn by eye

LawtonLobster1993PassmaBay.WOR *(Passamaquoddy Bay area)*

Relative lobster abundance determined by transects and collection dives (Lawton, 1993)
Data type: MapInfo TAB file drawn by eye

Folder: Lorneville&Coast

MckLorneville&Coast.WOR
Lorneville and Coastal Areas: Number of species recorded by MacKay (1975)
Data type: Excel data file

Musq-LornevilleMckNoSpp.WOR
Figure G2. Musquash - Lorneville Harbour: Number of species recorded during surveys (MacKay, 1975)
Data type: Excel data file

Folder: MachiasSeal

MSI-SealHauloutsAreas.WOR
Machias Seal Island seal haulouts (CCRM, 1999)
Data type: MapInfo TAB file

Folder: MDBurt'sReport

AtlPuffinDistrib.WOR
Distribution of Atlantic Puffin habitat in the Quoddy Region (Burt, 1997)
Data type: MapInfo TAB file drawn by eye

FinbackDistrib.WOR
Finback Whale (*Balaenoptera physalus*) distribution in Quoddy Region (Burt, 1997)
Data type: MapInfo TAB file drawn by eye

HbrPorpoiseDistrib.WOR
High (H) and medium (M) abundances of harbour porpoise (*Phocoena phocoena*) distribution (Burt, 1997)
Data type: MapInfo TAB file drawn by eye

HumpbackDistrib.WOR
Humpback Whale (*Megaptera novaeangliae*) distribution in Quoddy Region (Burt, 1997)
Data type: MapInfo TAB file drawn by eye

KelpDistrib.WOR
Distribution of Kelp (*Laminaria longicruris*) habitat in the Quoddy Region (Burt, 1997)
Data type: MapInfo TAB file drawn by eye

MinkeWhaleDistrib.WOR
Minke whale (*Balaenoptera acutorostrata*) distribution in Quoddy Region (Burt, 1997)
Data type: MapInfo TAB file drawn by eye

OpenWaterSppAggregate.WOR
Aggregate habitat scores for open water evaluation species as done in Burt, 1997
Data type: MapInfo TAB file drawn by eye

RightWhaleConsZone.WOR
Right whale (*Eubalaena glacialis*) Conservation Zone in Quoddy Region (Murison, 1997 in Burt, 1997)
Data type: Excel and MapInfo TAB files

RightWhaleDistrib.WOR
Right whale (*Eubalaena glacialis*) distribution in Quoddy Region (Burt, 1997)
Data type: MapInfo TAB file drawn by eye

SandDollarDistrib.WOR
Sand dollar (*Echinarachinius parma*) habitat in Quoddy Region (Burt, 1997)
Data type: MapInfo TAB file drawn by eye

Folder: MFD Website

AtlanticCodDist96-01.WOR
Distribution of Atlantic cod from summer surveys (1996-2001) (MFD Virtual Data Centre)

AltlanticHalibutDist96-01.WOR
Distribution of Atlantic halibut from summer surveys (1996-2001) (MFD Virtual Data Centre)

AnnapolisBayMacroF.WOR
Total weight of macrofauna for Annapolis Bay (DFO, Virtual Data Centre).
Data type: Excel extracted from MFD website

BarndoorSkateDist96-01.WOR
Distribution of Barndoor skate from summer surveys (1996-2001) (MFD Virtual Data Centre)

BayofFundyMacroF.WOR
Distribution of major Phylum (as percentage of species sampled) in the mid-lower Bay of Fundy (DFO, Virtual Data Centre)
Data type: Excel extracted from VDC website

ChignectoAreaMacroF.WOR
Distribution of major Phylum (as percentage of species sampled) in the upper Bay of Fundy (DFO, Virtual Data Centre)
Data type: Excel extracted from VDC website

GFish4VX&5ZStrata.WOR
Boundaries of groundfish strata 4XVW and 5Z
Boundaries are from tables extracted from ACON as Excel file

GFishAverageStrata.WOR
Average number of species obtained in fishing strata during Groundfish Surveys from 1991-2000 (Marine Fish Division Website data)
Data type: Excel extracted from MFD website

GFishAverageStrata2000.WOR
(Folder: MFD website)
Data type: Excel extracted from MFD website

GM&GoMMacrofauna.WOR
Total weight of macrofauna for Grand Manan & lower Bay of Fundy (GOM) (DFO, Virtual Data Centre)
Data type: Excel extracted from VDC website

Groundfish91-99NoSpp.WOR
Number of fish species caught during research surveys from 1991-99 (DFO, Virtual Data Centre)
Data type: Excel extracted from VDC website

HaddockDist96-01.WOR
Distribution of haddock from summer surveys (1996-2001) (MFD Virtual Data Centre)

HerringDist96-01.WOR
Distribution of herring from summer surveys (1996-2001) (MFD Virtual Data Centre)

MinasBasinMacrofauna.WOR
Distribution of major Phylum (as percentage of species sampled) in Minas Basin (DFO, Virtual Data Centre)
Data type: Excel extracted from VDC website

SaintJohnHbrMacroF.WOR
Distribution of major Phylum (as percentage of species sampled) in Saint John Harbour (DFO, Virtual Data Centre)
Data type: Excel extracted from VDC website

WinterFlounderDist96-01.WOR
Distribution of winter flounder from summer surveys (1996-2001) (MFD Virtual Data Centre)

Folder: MusselBioherms

MusselBioherms.WOR

Areas of high horse mussel density = mussel bioherms (Wildish et al., 1998)
Data type: Excel file

Folder: NBAlgaeReport

Charlotte-ChlorophycoDistribution.WOR
Distribution of Chlorophycophyta (*Enteromorpha, Ulva, Monostroma*) (Neish, 1973)
No Data: MapInfo Layer

Charlotte-Chorda&LDigitaDistn.WOR
Distribution of Laminariales (*Chorda filum, Laminaria digitata*) (Neish, 1973)
No Data: MapInfo Layer

Charlotte-LaminariaDistribution.WOR
Distribution of wide-frond *Laminaria longicruris* (Neish, 1973)
No Data: MapInfo Layer

Charlotte-PorphyraDistribution.WOR
Distribution of *Porphyra* (Neish, 1973)
No Data: MapInfo Layer

GM-ChlorophycophytaDistn.WOR
Distribution of Chlorophycophyta (*Enteromorpha, Ulva, Monostroma*) (Neish, 1973)
No Data: MapInfo Layer

GM-ChordaLDigitaDistnn.WOR
Distribution of Laminariales (*Chorda filum, Laminaria digitata*) (Neish, 1973)
No Data: MapInfo Layer

GMLaminariaDistribution.WOR
Distribution of wide-frond *Laminaria longicruris* (Neish, 1973)
No Data: MapInfo Layer

GM-PorphyraDistn.WOR
Distribution of *Porphyra* (Neish, 1973)
No Data: MapInfo Layer

Folder: Oceanographic

GenSurCircQuoddyRegion.WOR
General surface circulation for the Quoddy Region (Chevrier, 1959)
Data type: MapInfo TAB file drawn by eye from scanned map

SurfCirc.WOR
Surface circulation in the Bay of Fundy. Layers for spring, summer, fall and winter. Drawn by eye from McGuire (1977)

Data type: MapInfo TAB files drawn by eye

WinterBottomTemp.WOR
Bottom winter temperatures for Bay of Fundy - Gulf of Maine (Extracted from MFD Website)
Data type: MapInfo TAB file drawn by eye from scanned map

WinterBottomTempCropped.WOR
Bottom winter temperatures for Bay of Fundy - Gulf of Maine (Extracted from MFD Website)
Cropped to line separating BoF and Scotian Shelf

LBoFWaterSourcesMay.WOR
Water sources during May for Lower Bay of Fundy (Bumpus et al. 1959)
Data type: MapInfo TAB file drawn by eye from scanned map

LBoFWaterSourcesJan.WOR
Water sources during January for Lower Bay of Fundy
Data type: MapInfo TAB file drawn by eye from scanned map

Folder: ParksCanadaReport

NACSareasBoF.WOR
Marine Natural Areas of Canadian Significance in the Bay of Fundy (Parks Canada/Tourism New Brunswick, 1985)
Data type: MapInfo TAB file drawn by eye

NACS-WestIsles.WOR
West Isles Natural Area of Canadian Significance (Parks Canada/Tourism New Brunswick, 1985)
Data type: MapInfo TAB file drawn by eye

WestIslesOceanogr.WOR
Oceanography of the West Isles area (Parks Canada/Tourism NB, 1985)
Data type: MapInfo TAB file drawn by eye

WestIslesMammals.WOR
Marine mammals in the West Isles (Parks Canada/Tourism NB, 1985)
Data type: MapInfo TAB file drawn by eye

WestIslesBirds.WOR
Marine and shorebird nesting and feeding areas in the West Isles (Parks Canada/Tourism NB, 1985)
Data type: MapInfo TAB file drawn by eye

Folder: PassamaquoddyBay

PB-Aqua01&WeirsCCRM.WOR
Passamaquoddy Bay aquaculture sites, bay management areas (October 2001) and herring weirs (CCRM, 1999)
Data type: Excel and MapInfo files

PassScallopBedsCCRM.WOR
Scallop beds (CCRM, 1999)
Data type: MapInfo TAB file

PB-SeaCukeFishEffort2002.WOR
Sea Cucumber 2000 Fishing Effort (M. Lundy, per. com., 2002)
Data type: Excel

Passma-Lawton93LobsDistri.WOR
Figure G1. Relative abundance of lobsters recorded from transects and collection dives (Lawton, 1983)
Data type: MapInfo TAB file drawn by eye

Mackay.WOR
Stations for MacKay records: stations only
Data type: Excel file

MackayNoSpp.WOR
Number of species recorded at 128 spot examination sites (MacKay et al., 1978)
Data type: Excel file

PassB-ShorelineClass.WOR
Shoreline classification (CCRM, 1999)
Data type: MapInfo TAB file

PB-SamOrrsPond.WOR
Map showing location of Sam Orr's Pond
Data type: MapInfo TAB file done by eye

SofShellClamsCCRM.WOR
Soft-shelled clam beds (CCRM, 1999)
Data type: MapInfo TAB file

Folder: PeaPt-Pt.Lepreau

PPPL-HerringWeir.WOR
Location of herring weirs (CCRM, 1999).

PP-PLScallopBed.WOR
Scallop beds (CCRM, 1999)

Data type: MapInfo TAB file

PP-PLSoftShellClam.WOR
Soft-shelled clam beds (CCRM, 1999)
Data type: MapInfo TAB file

PP-PLScallop&SSClamsBed.WOR
Scallop and Soft-shelled clam beds (CCRM, 1999)

PPPL-ShorelineClass.WOR
Shoreline classification (CCRM, 1999)
Data type: MapInfo TAB file

MacesBaySealHaulouts.WOR
Seal haulout locations (CCRM, 1999)
Data type: MapInfo TAB file

McKNoSppPeaPt-PtLep.WOR
Number of species recorded during 53 intertidal and subtidal spot examinations and 5 transects (MacKay et al., 1978). *(Beaver Harbour - Pt. Lepreau)*
Data type: Excel data and MapInfo TAB file

McKNoSppPeaPt-PtLep&BBLI.WOR
Number of species recorded by MacKay et al. (1978, 1979). *(Maces Bay and Back Bay-Letang Inlet)*
Data type: Excel data and MapInfo TAB file

Folder: Periwinkle

BeaverHbr-Maces-PeriwAreas.WOR
Periwinkle harvesting locations (CCRM, 1999)
Data type: MapInfo TAB file

DI-Campo-PeriwAreas.WOR
Periwinkle harvesting locations (CCRM, 1999)
Data type: MapInfo TAB file

GM-PeriwinkleAreas.WOR
Periwinkle harvesting locations (CCRM, 1999)
Data type: MapInfo TAB file

LetangEst-PeriwAreas.WOR
Periwinkle harvesting locations (CCRM, 1999)
Data type: MapInfo TAB file

TheWolves-PeriwAreas.WOR

Periwinkle harvesting locations (CCRM, 1999)
Data type: MapInfo TAB file

Folder: Plankton

Copepods69.WOR
Distribution of copepods during 1969 (Isles, 1974)
Data type: MapInfo polygons from scanned images

Euphausids69.WOR
Distribution of euphausiids during 1969
Data type: MapInfo polygons from scanned images

SagittaNov74.WOR
Distribution of *Sagitta elegans* during November 1974
Data type: MapInfo polygons from scanned images

SagittaOctNov69.WOR
Distribution of *Sagitta elegans* during October-November 1969
Data type: MapInfo polygons from scanned images

Folder: ProposedMPAs

GOMIntlWildernessMPA.WOR
The proposed Gulf of Maine International Ocean Wilderness MPA starts 12 miles offshore and follows The Hague Line to the outer limits of the EEZ (Web site: www.atlantisforce.org/)
Data type: MapInfo TAB file done by eye

GOMIntlWildernessMPA1.WOR
Similar to above

IMMA-QuoddyMPA.WOR
Quoddy Region MPA proposed by the International Marine Mammal Association (IMMA Web site: imma.org/education/quoddympa.html)
Data type: MapInfo TAB file done by eye

MCBIproposedMPAs.WOR
All the proposed benthic MPAs in the Gulf of Maine/Bay of Fundy (MCBI web site) *(Obtained from ESRI shape files provided by MCBI)*
Data type: ESRI shape files provided by MCBI

Wein&Jones-Hunter&Assoc.WOR
Proposed ecological reserves (Wein & Jones, 1975; Hunter & Associates, 1982). *(Done by eye from original reports.)*
Data type: MapInfo TAB file done by eye

Folder: PtLepreau-SJ

SJ-PtLScallopBeds.WOR
Scallop beds (CCRM, 1999)
Data type: MapInfo TAB file

SJ-PtLSoftShellClam.WOR
Soft-shelled clam beds (CCRM, 1999)
Data type: MapInfo TAB file

SJ-PtLShorelineClass.WOR
Shoreline classification (CCRM, 1999)
Data type: MapInfo TAB file

Folder: QuoddyRegionMap

QuoddyRegionBoundary.WOR
The boundaries of the Quoddy Region (see Thomas, 1984)
Data type: MapInfo TAB file done by eye

Folder: Robichaud&etal87

NoLobsStMarysDives87.WOR
Number of lobsters recorded per 1000 m² during diving surveys in St. Mary's Bay (Robichaud et al., 1987)
Data type: Excel data file

NoLobsStMarysTows87.WOR
Number of lobsters recorded per 1000 m² rockhopper trawl surveys in St. Mary's Bay (Robichaud et al., 1987)
Data type: Excel data file

Folder: Saltmarshes

(Community Coastal Resource Mapping, 1999; the first 3 workspaces captures all the salt marshes recorded by CCRM)

BackBay-RedHdHbrSaltMarshes.WOR
Locations of salt marshes (CCRM, 1999) *(Back Bay to Red Head Harbour - red dots)*
Data type: MapInfo TAB file
BoFWesternSaltmarsh1.WOR
Locations of salt marshes (CCRM, 1999) *(Upper BoF above Saint John - red dots)*
Data type: MapInfo TAB file

BoFWesternSaltmarshes.WOR

Locations of salt marshes (CCRM, 1999) *(Upper BoF above Saint John - yellow polygons)*
Data type: MapInfo TAB file

DI-Campo-SaltMarshes.WOR
Locations of salt marshes (CCRM, 1999) *(Deer Island - Campobello - red dots)*
Data type: MapInfo TAB file

GM-SaltMarshes.WOR
Locations of salt marshes (CCRM, 1999) *(Grand Manan -red dots)*
Data type: MapInfo TAB file

MacesBay-SJ-SaltMarsh.WOR
Locations of salt marshes (CCRM, 1999) *(Maces Bay to Saint John - red dots)*
Data type: MapInfo TAB file

MinasBasinSaltmarshes1.WOR
Locations of salt marshes (CCRM, 1999) *(Minas Basin area only -red dots)*
Data type: MapInfo TAB file

MinasBasinSaltmarshes.WOR
Locations of salt marshes (CCRM, 1999) *(Minas Basin area only - yellow polygons)*
Data type: MapInfo TAB file

PassmaBay-SaltMarshes.WOR
Locations of salt marshes (CCRM, 1999) *(Passamaquoddy Bay - St. Croix Estuary - red dots)*
Data type: MapInfo TAB file

SJ-PtLepreauSaltmarshes.WOR
Locations of salt marshes (CCRM, 1999) *(Saint John-Point Lepreau - yellow polygons)*
Data type: MapInfo TAB file

Folder: SAW-Maps&Docs
Sub-folder: Sackville-Workshop

CWSBirdAreasAcquisitions.WOR
Areas where coastal land acquisitions are recommended and being pursued by Canadian Wildlife Service (K. Davidson, pers. com.)
Data type: MapInfo TAB file drawn by eye

HicklinSBayMinasBasin.WOR
Shepody Bay and Minas Basin Mudflats: significant areas (Hicklin, 01)
Data type: MapInfo TAB file drawn by eye

MaryMajka-MaryPt-GIslandArea.WOR

Mary's Point Grindstone Island Area: significant area (Mary Majka, 2001)
Data type: MapInfo TAB file drawn by eye

SaraRichard.WOR
Areas around which land acquisitions are being pursued by the EHJV (Richards, 2001)
Data type: MapInfo TAB file drawn by eye

Sub-Folder: UNBSJ-Workshop

ChopinGrandManan.WOR
Seaweed research sites (Chopin et al., 2001)
Data type: MapInfo TAB file drawn by eye

ChopinGreensPoint.WOR
Seaweed research sheltered and exposed sites Green's Point (Chopin et al., 2001)
Data type: MapInfo TAB file drawn by eye

ChopinMacesBay.WOR
Seaweed research sites - Maces Bay (Chopin et al. 2001)
Data type: MapInfo TAB file drawn by eye

DiamondAreas.WOR
Areas identified as being important to seabirds (Diamond, 2001)
Data type: MapInfo TAB file drawn by eye

ThomasLLetetePassage.WOR
Little Letite Passage significant area (Thomas, 2001
Data type: MapInfo TAB file drawn by eye

ThomasMusquashHd.WOR
Musquash Head significant area (Thomas, 2001)
Data type: MapInfo TAB file drawn by eye

Folder: Sea Cukes-Lundy

West isles sea cukes.WOR
Sea Cucumber 2000 Fishing Effort (M. Lundy, per. com., 2002)
Data type: Excel

Folder: SpeciesDistribution *(These workspaces were generated from the data from all the MacKay Reports and Kenchington's scallop bycatch data. Only the occurrence of individual species are indicated, locations where they were not found are not indicated)*

AlcyoniumDist.WOR
Alcyonium distribution as recorded from scallop bycatch (Kenchington, 1999)
Data type: Excel data file

AmphitriteDist.WOR
Distribution of the annelid *Amphitrite sp.* (MacKay 1975-79, Kenchington 1999)
Data type: Excel data file

ClionaSpongeDist.WOR
Dsitribution of the Sulphur Boring Sponge (*Cliona*) (MacKay 1975-79, Kenchington 1999)
Data type: Excel data file

DIC-IndicatorSpp.WOR
Distribution of indicator species in the West Isles area (MacKay et al., 1978, 1979)

EdwardsiaDist.WOR
Edwardsia sipuncularia distribution (MacKay, 1975-79)

GersemiaDist.WOR
Gersemia distribution (MacKay 1975-79, Kenchington, 1999)
Data type: Excel data file

HalichondriaDist.WOR
Halichondria distribution (MacKay 1975-79, Kenchington 1999)
Data type: Excel data file

HaliclonaDist.WOR
Distribution of the sponge Deadman's Fingers (*Haliclona oculata*) (Mackay 1975-79, Kenchington 1999)
Data type: Excel data file

HalocynthiaDist.WOR
Halocynthia pyriformis (Sea Peach) distribution (MacKay 1975-79, Kenchington 1999)
Data type: Excel data file

SeaPotatoDist.WOR
Boltenia ovifera (Sea potato) distribution (MacKay 1975-79, Kenchington 1999)
Data type: Excel data file

Folder: Stephenson-herring

HerringFishingLocStephenson.WOR
Fishing locations for herring in southwest and coastal Nova Scotia (Stephenson et al., 1999)
Data type: MapInfo TAB file drawn by eye

HerrSpawning AreasTibbo59.WOR
Herring spawning areas (Tibbo, 1959)

Data type: MapInfo TAB file drawn by eye from scanned map

WhaleObsBrierStephenson.WOR
General area of whale observations for the Brier Island area in August for 1985-98 (Power et al., 1999)
Data type: MapInfo TAB file drawn by eye

Folder: Strong&Hanke95

Strong&HankeFinfishDiversity.WOR
Spatial patterns of diversity of finish species in summer tows 1990-1993 (Strong & Hanke, 1995)
Data type: MapInfo TAB file drawn by eye from scanned map

Folder: Terhune

SealHaulOutsTerhune.WOR
Locations of known seal haulouts from Saint John to Passamaquoddy Isles, following the coastline, excluding Grand Manan and The Wolves, from 1986 aerial surveys (Terhune, unpublished)
Data type: MapInfo TAB file drawn by eye

PLSJ-SealHaulOutsTerhune&CCRM.WOR
Locations of known seal haulouts from PL-SJ, following the coastline from 1986 aerial surveys (Terhune, unpublished). Also haulouts from CCRM (1999)

PPPL-SealHaulOutsTerhune&CCRM.WOR
Locations of known seal haulouts from PP to PL following the coastline from 1986 aerial surveys (Terhune, unpublished). Also haulouts from CCRM (1999)

PPPL-SealHaulOutsTerhune.WOR
Locations of known seal haulouts from PP to PL following the coastline from 1986 aerial surveys (Terhune, unpublished)

BBLI-SealHaulOutsTerhune.WOR
Locations of known seal haulouts from Back Bay to Letang Inlet following the coastline from 1986 aerial surveys (Terhune, unpublished)

Folder: TheWolves

TheWolvesFishingWeirs.WOR
Location of fishing weirs (CCRM, 1999)
Data type: MapInfo TAB file

TheWolvesMckNoSpp.WOR
The Wolves: Number of Species (flora and fauna) (MacKay & Bosien, 1979)

Data type: Excel file

TheWolvesScallopBed.WOR
Scallop beds (CCRM, 1999)
Data type: MapInfo TAB file

TheWolvesShoreClass.WOR
Shoreline classification (CCRM, 1999)
Data type: MapInfo TAB file

Folder: Trippel et al

Gillnet&HbrPorp.WOR
Fishing ports, areas where gillnets were set, routes followed by vessels to fishing areas, and areas where incidental catches of harbour porpoises in commercial gill nets were observed in 1993 and 1994 (Trippel et al. 1996a)
Data type: MapInfo TAB file drawn by eye from scanned map

GillnetDistnGM.WOR
Distribution of demersal gillnet strings having different alarm conditions in the Swallowtail area, Grand Manan Island, New Brunswick, on August 7-8, 1996 (Trippel et al., 1996b)
Data type: MapInfo TAB file drawn by eye from scanned map

Folder: UpperBayofFundy *(Community Coastal Resource Mapping, 1999)*

MinasB-Scallop&SSClams.WOR
Scallop and Soft-shelled clam beds (CCRM, 1999)
Data type: MapInfo TAB file

SJ-FNP-SoftShellClam.WOR
Soft-shelled clam beds (CCRM, 1999)
Data type. MapInfo TAB file

SJ-UBoFScallopBeds.WOR
Scallop beds (CCRM, 1999)
Data type: MapInfo TAB file

UBoF-SoftShellClam.WOR
Scallop beds (CCRM, 1999)
Data type: MapInfo TAB file

UBoF-ShorelineClass.WOR
Shoreline classification (CCRM, 1999)
Data type: MapInfo TAB file

UBoF-SealHaulout.WOR
Sea haulout locations (CCRM, 1999)
Data type: MapInfo TAB file

UBoF-SoftShellClam.WOR
Soft-shelled clam beds (CCRM, 1999)
Data type: MapInfo TAB file

Folder: WholeBayofFundyMap

ToddsPointSigArea.WOR
Todd's Point on the St. Croix Estuary: 170 acres land and 160 acres intertidal area
Data type: MapInfo TAB file drawn by eye

Signif&Proposed.WOR
This workspace pulls together all the proposed MPA and relevant protected areas
Data type: MapInfo TAB files

WholeBoFSaltMarshAll.WOR
Figure 4. Location of salt marshes in the Bay of Fundy (CCRM, 1999)
Data type: MapInfo TAB file

WholeBoF-InsertBoxes.WOR
Figure 1. Areas for which more detailed maps are provided
Data type: MapInfo TAB file drawn by eye

WholeBofFSignif.WOR
Bay of Fundy areas identified as significant or as potential MPAs. (Various references, see Table F.1)
Data type: MapInfo TAB file drawn by eye

WholeBoFCoastline.WOR:
Coastlines of the whole Bay of Fundy as in the Community Coastal Resources CD
Data type: MapInfo TAB file

WholeBofF&Boxes.WOR
Coastline and 4003 map of the whole B of F with numbered locations
Data type: MapInfo TAB file drawn by eye

WholeBoF-PrimProduction.WOR
Primary production from regions in the Bay of Fundy (Prouse, et al. 1984)

WholeBofFWeirs.WOR
Coastline and 4003 map of whole Bay of Fundy: Location of fishing weirs (Community Coastal Resource Mapping, 1999)
Data type: MapInfo TAB file

Folder: Wildish77

LetangEstuary.WOR
Number of sublittoral macrofauna species from triplicate samples (Wildish et al., 1977).
Data type: Excel data file

StCroixDidgeguash.WOR
Number of species of sublittoral macrofauna sampled (Wildish et al., 1977, 1980)
Data type: Excel data file

Folder: WWF-Seascapes

J - DATA MAPS

Fig C.1. Location of Bay of Fundy within the Gulf of Maine, and of sites reviewed in this document. Numbers refer to subsections in Section D.

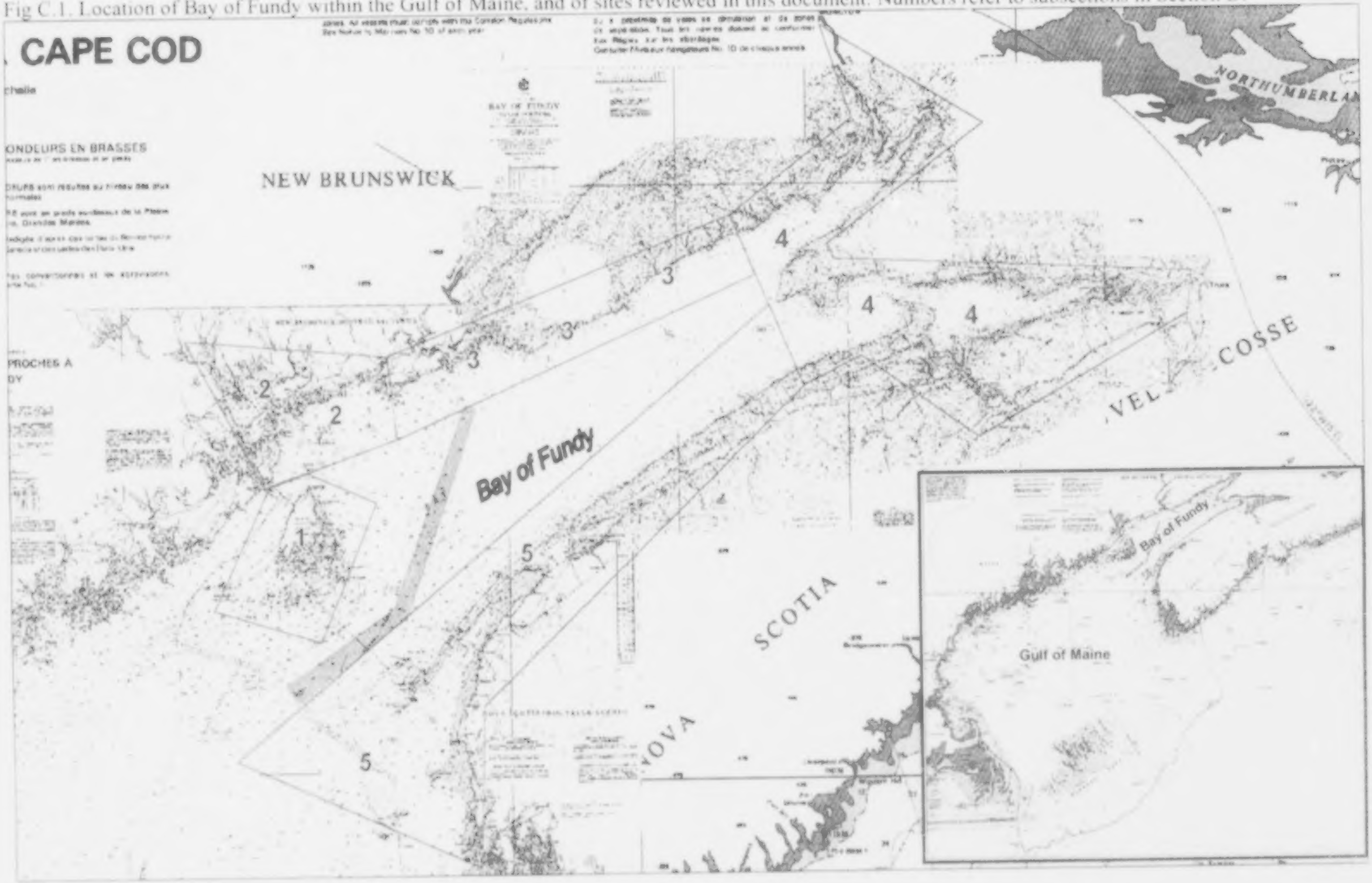

CAPE COD
ONDEURS EN BRASSES
NEW BRUNSWICK
NORTHUMBERLA
PROCHES A
DY
Bay of Fundy
NOVA SCOTIA
VEL COSSE
1
2
2
3
3
3
3
4
4
4
4
5
5
Bay of Fundy
Gulf of Maine

Fig. C.2. Winter surface circulation in the Bay of Fundy (after McGuire, 1977).

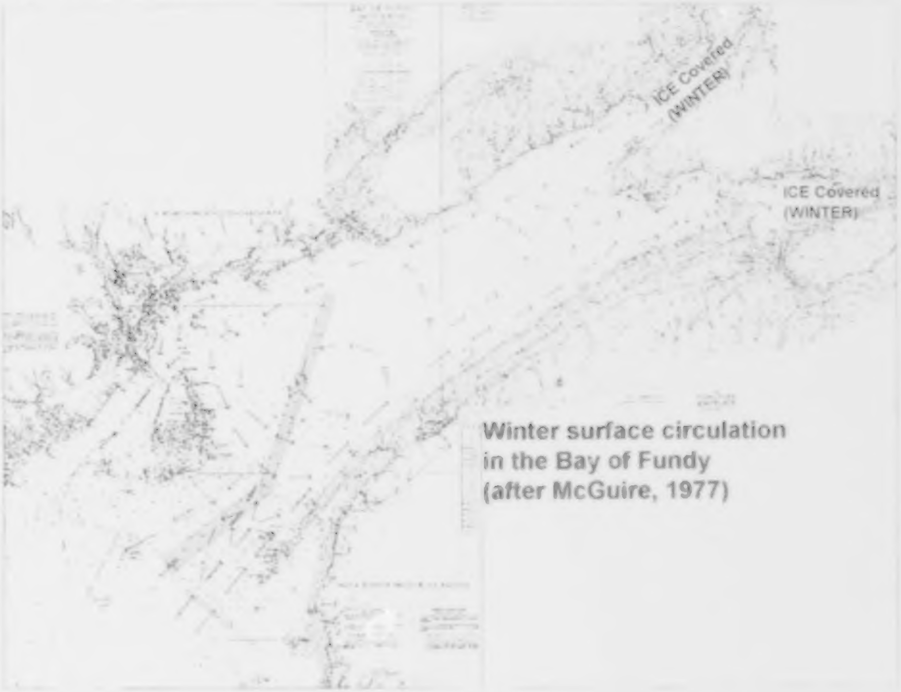

ICE Covered (WINTER)
ICE Covered (WINTER)
Winter surface circulation in the Bay of Fundy (after McGuire, 1977)

Fig. C.3. Summer surface circulation in the Bay of Fundy (after McGuire, 1977).

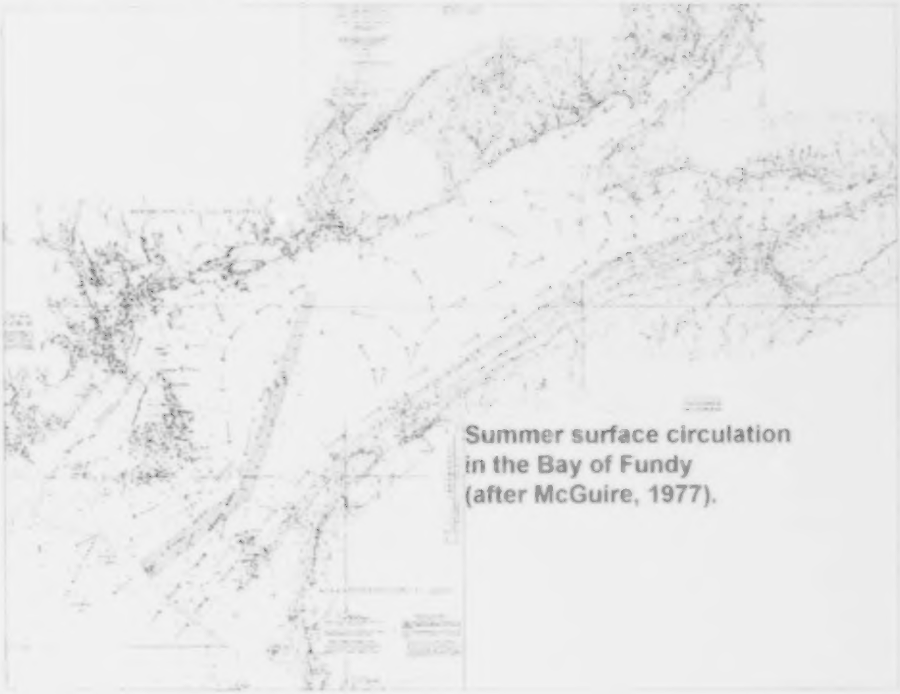


Fig. C.4. Surface water circulation contours during January determined from drift water bottle distribution (Bumpus, 1959).

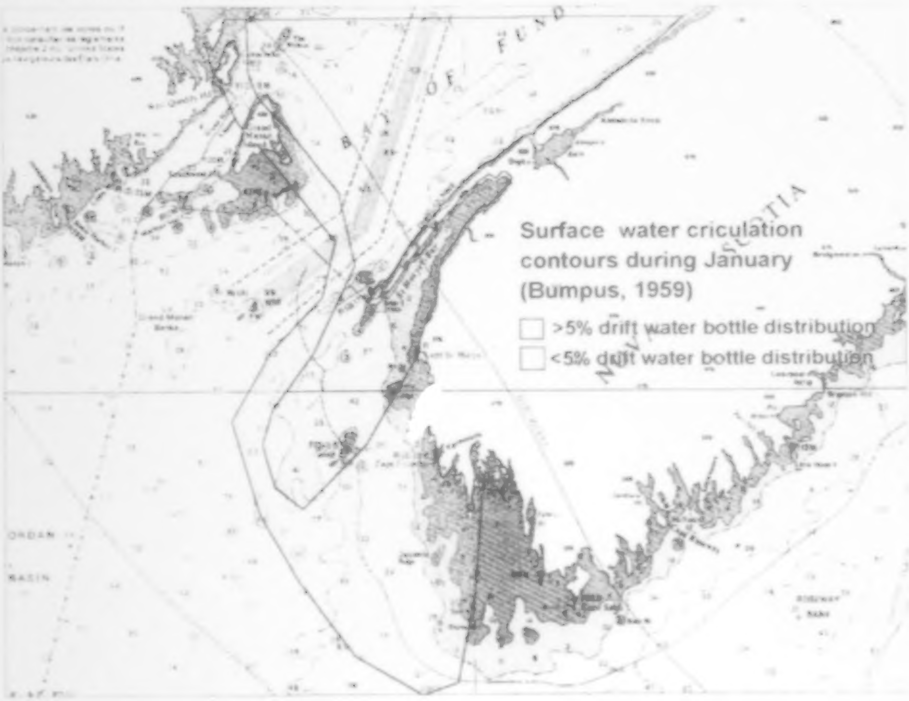

BAY OF FUNDY
NOVA SCOTIA
Surface water criculation contours during January (Bumpus, 1959)
☐ >5% drift water bottle distribution
☐ <5% drift water bottle distribution

Fig. C.5. Surface water circulation contours during May determined from drift water bottle distribution (Bumpus, 1959).

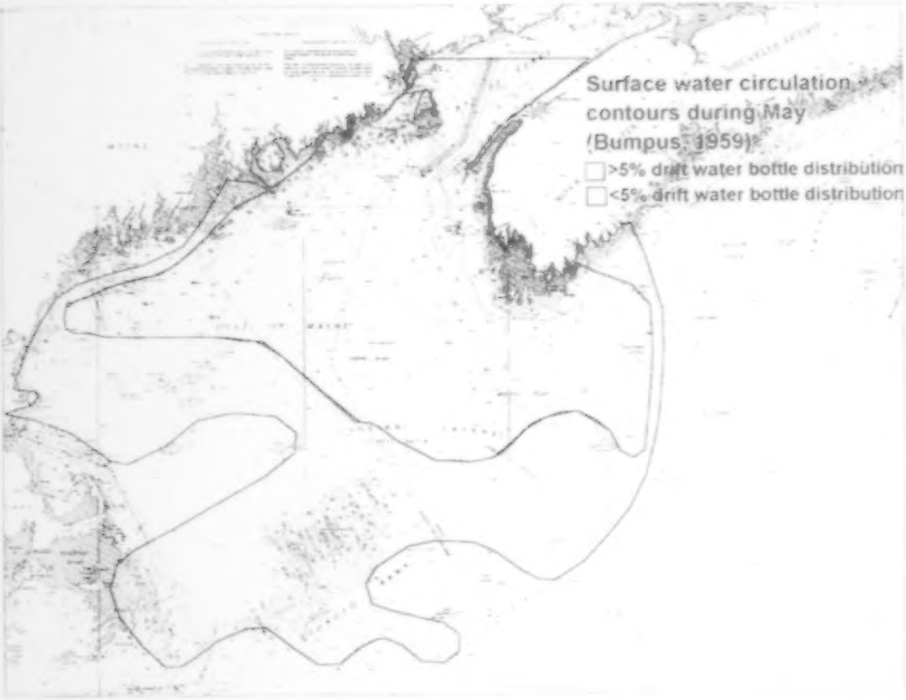

Surface water circulation contours during May (Bumpus, 1959)
☐ >5% drift water bottle distribution
☐ <5% drift water bottle distribution

Fig. C.6. Winter bottom temperatures (DFO).

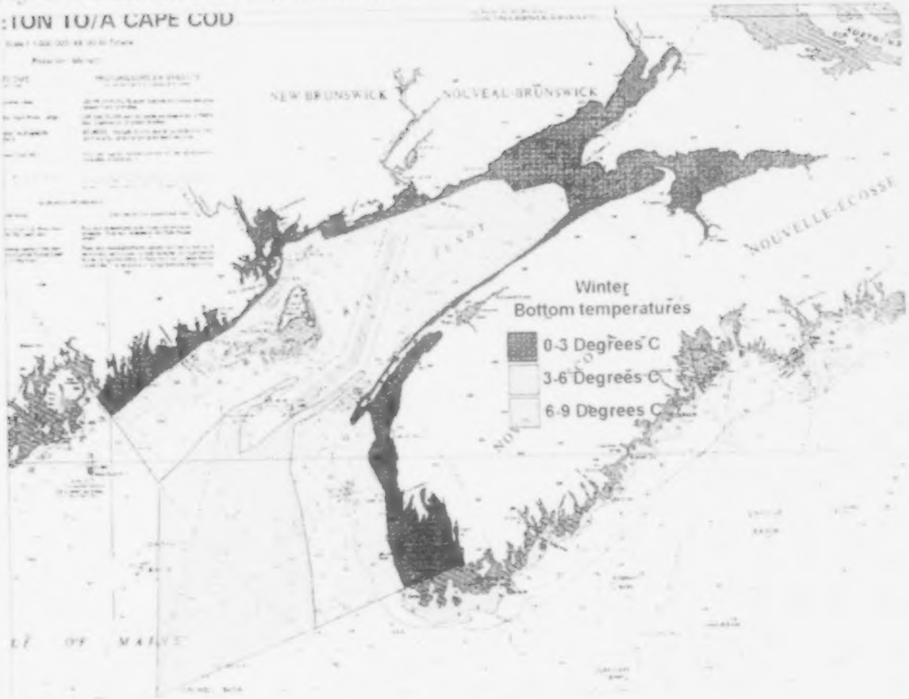

:TON TO/A CAPE COD
NEW BRUNSWICK
NOUVEAU-BRUNSWICK
NOUVELLE-ECOSSE
FUNDY
Winter
Bottom temperatures
0-3 Degrees C
3-6 Degrees C
6-9 Degrees C
OF MAINE

Fig. C.7. Summer bottom temperatures (DFO).

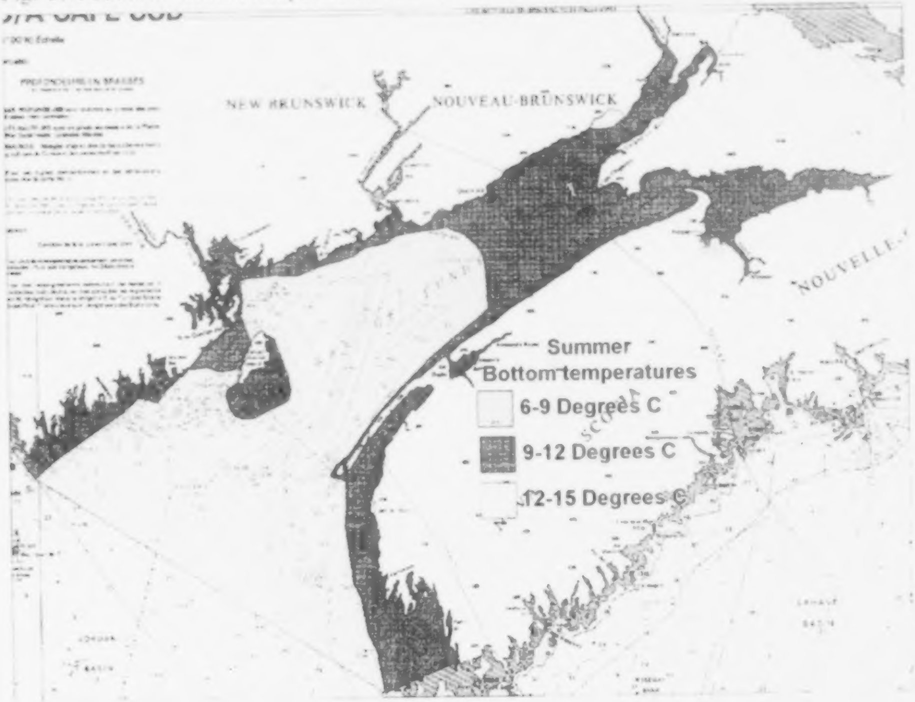

O/A CAPE COD
PROFONDEURS EN BRASSES
NEW BRUNSWICK
NOUVEAU-BRUNSWICK
NOUVELLE-
FUNDY
Summer
Bottom temperatures
6-9 Degrees C
9-12 Degrees C
12-15 Degrees C

Fig. C.8. Winter bottom salinities (DFO).

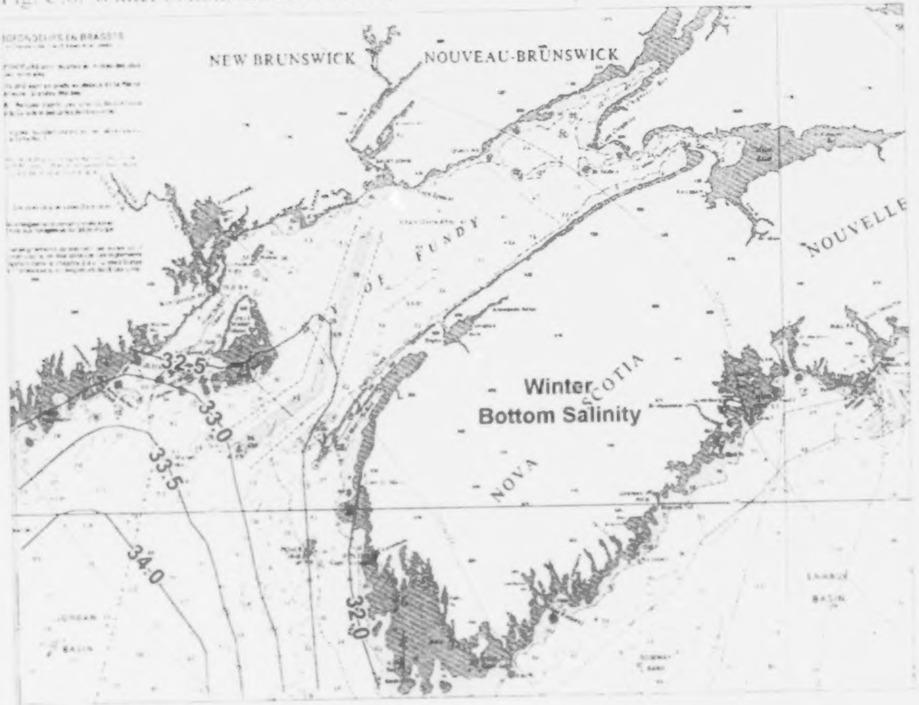

NEW BRUNSWICK
NOUVEAU-BRUNSWICK
BAY OF FUNDY
NOUVELLE
NOVA SCOTIA
Winter
Bottom Salinity
32.5
33.0
33.5
34.0
32.0
JORDAN BASIN
LAHAVE BASIN

Fig. C.9. Summer bottom salinities (DFO).

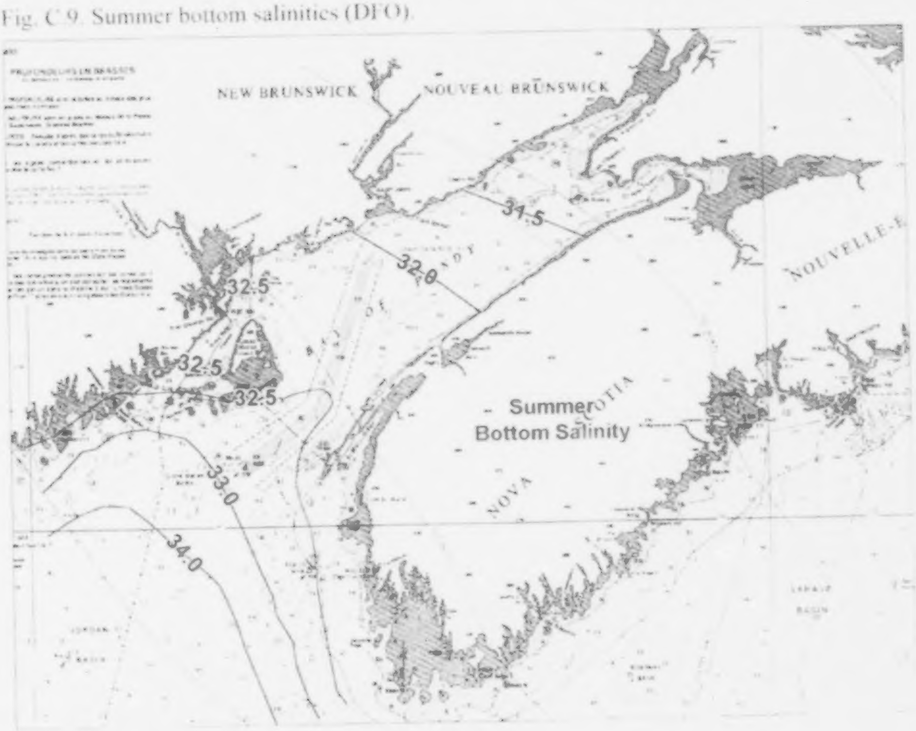

NEW BRUNSWICK
NOUVEAU-BRUNSWICK
31.5
32.0
32.5
32.5
32.5
33.0
34.0
NOUVELLE-E
NOVA SCOTIA
Summer
Bottom Salinity
JORDAN BASIN
LAHAVE BASIN

Fig. C.10. Total primary production by Bay of Fundy regions (C yr x 10^3) (Prouse et al., 1984) and locations of Bay of Fundy estuaries (Harvey et al., 1998).

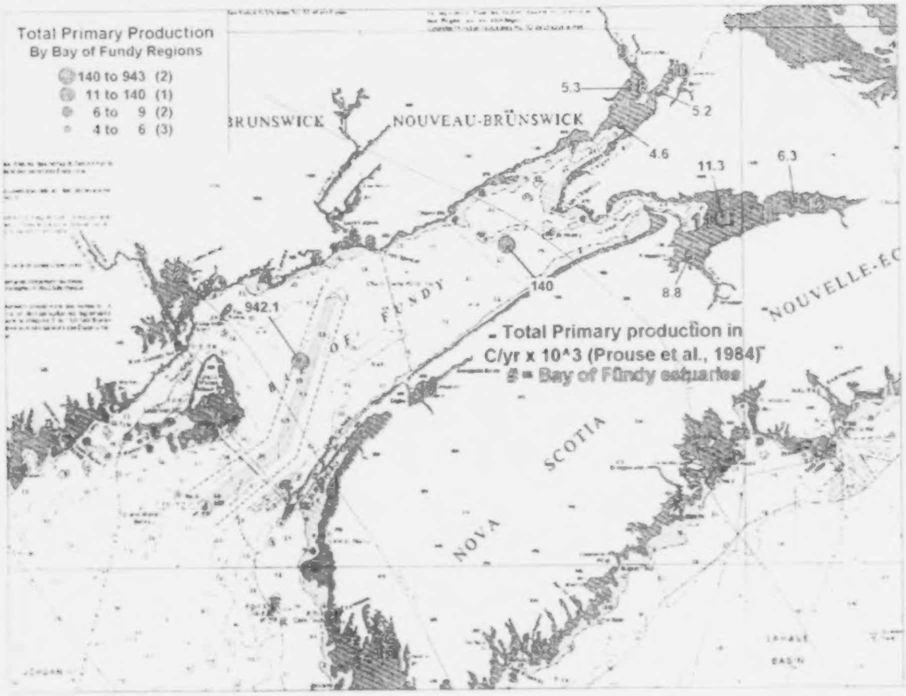

Total Primary Production
By Bay of Fundy Regions
140 to 943 (2)
11 to 140 (1)
6 to 9 (2)
4 to 6 (3)
BRUNSWICK
NOUVEAU-BRUNSWICK
5.3
5.2
4.6
11.3
6.3
140
8.8
942.1
BAY OF FUNDY
NOUVELLE-EC
- Total Primary production in C/yr x 10^3 (Prouse et al., 1984)
# = Bay of Fundy estuaries
NOVA SCOTIA
LAHAVE BASIN

Fig. C.11. Location of Bay of Fundy salt marshes (CCRM, 1999).

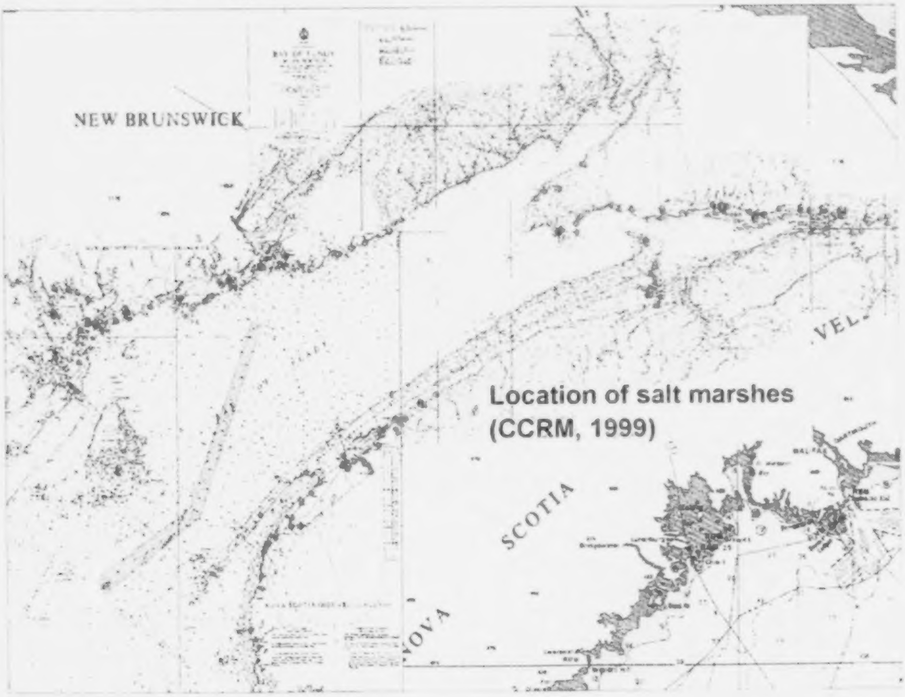
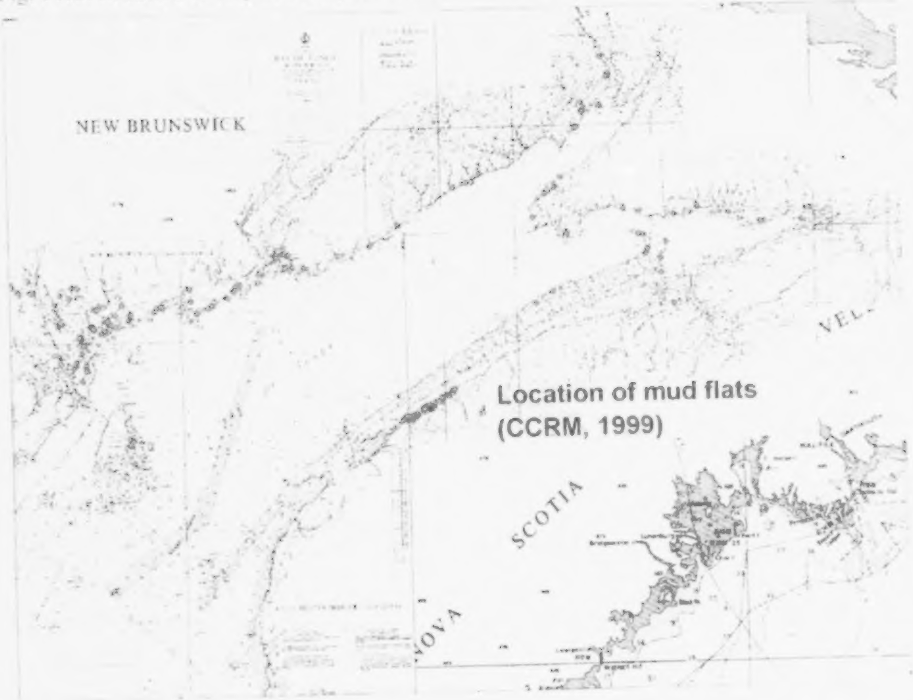

NEW BRUNSWICK
VEL
Location of salt marshes (CCRM, 1999)
NOVA SCOTIA

Fig. C.12. Location of Bay of Fundy mud flats (CCRM, 1999).


NEW BRUNSWICK
NOVA SCOTIA
VEL

Location of mud flats (CCRM, 1999)

Fig. C. 13. Geology of the Bay of Fundy.

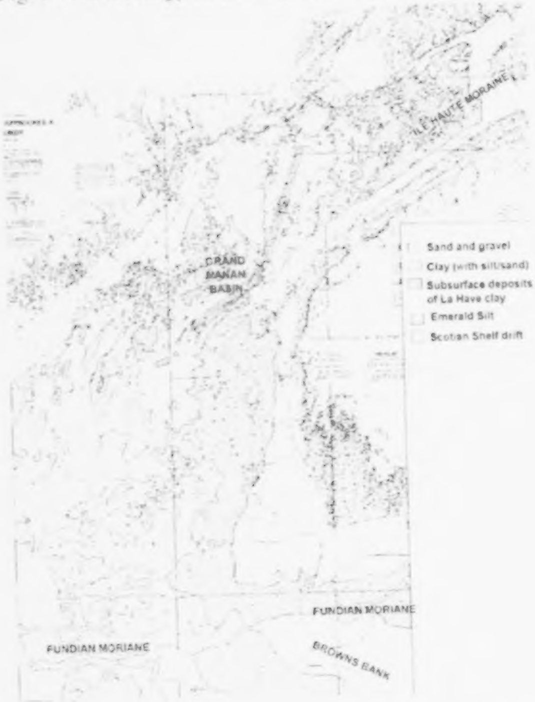

ILE HAUTE MORAINE
GRAND MANAN BASIN
Sand and gravel
Clay (with silt/sand)
Subsurface deposits of La Have clay
Emerald Silt
Scotian Shelf drift
FUNDIAN MORIANE
FUNDIAN MORIANE
BROWNS BANK

Fig. C.14. Locations of protected and managed areas within 5 km of the Bay of Fundy shoreline. See table in text for details on specific sites. (ARCAD, ACCDC data).

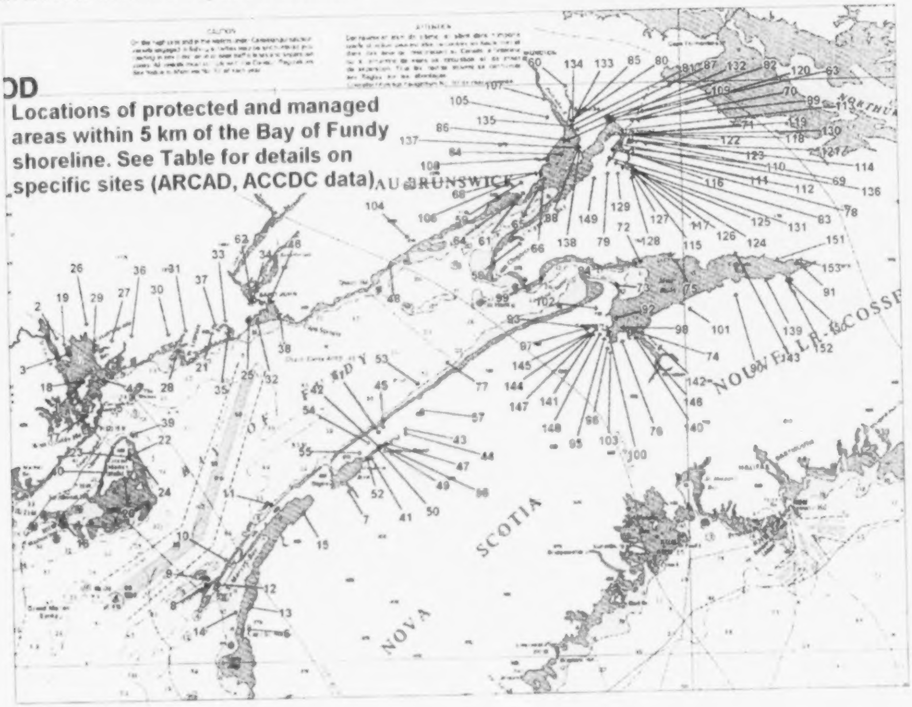

Locations of protected and managed areas within 5 km of the Bay of Fundy shoreline. See Table for details on specific sites (ARCAD, ACCDC data)
AU BRUNSWICK
NOVA SCOTIA
NOUVELLE-ÉCOSSE
CAUTION
ATTENTION

Fig. D.1.1. Grand Manan and surrounding area.

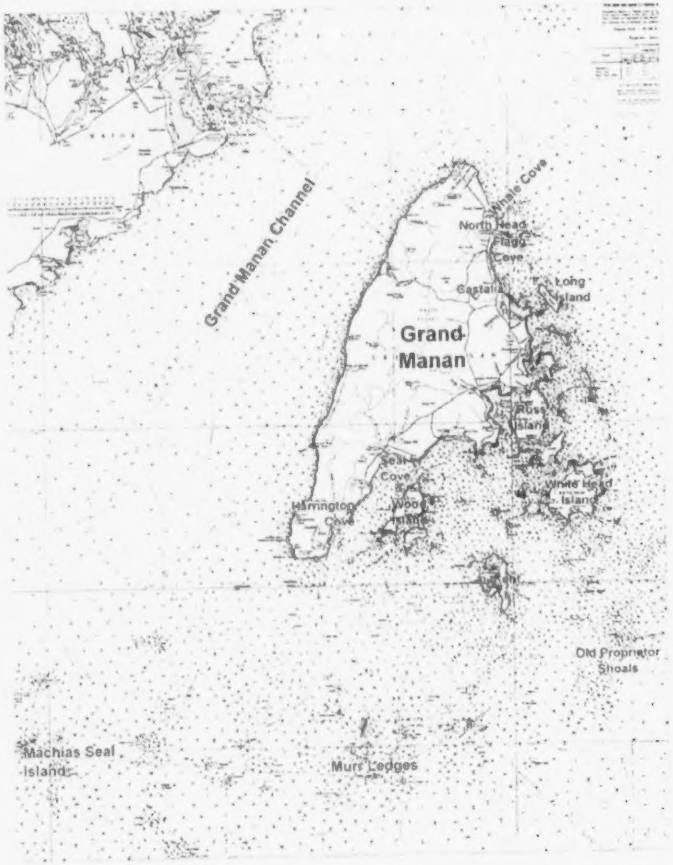

Grand Manan Channel
Whale Cove
North Head
Flagg Cove
Castalia
Long Island
Grand Manan
Ross Island
Seal Cove
White Head Island
Harrington Cove
Wood Island
Old Proprietor Shoals
Machias Seal Island
Murr Ledges

Fig. D.1.2. Shoreline classification for Grand Manan (CCRM, 1999).

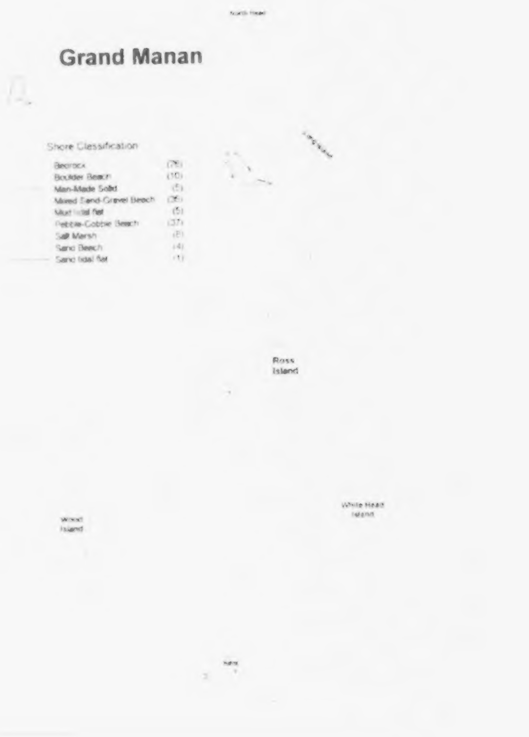

North Head
Grand Manan
Long Island
Shore Classification
Bedrock (78)
Boulder Beach (10)
Man-Made Solid (5)
Mixed Sand-Gravel Beach (35)
Mud tidal flat (5)
Pebble-Cobble Beach (37)
Salt Marsh (8)
Sand Beach (4)
Sand tidal flat (1)
Ross Island
Wood Island
White Head Island

Fig. D.1.3. Significant areas for seabirds around Grand Manan.

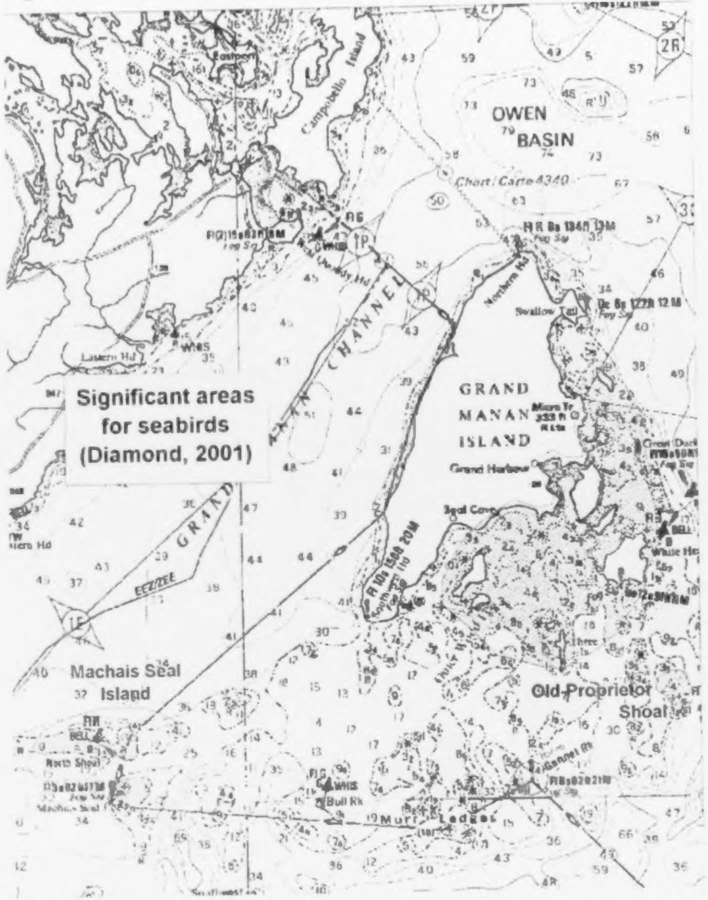

Significant areas
for seabirds
(Diamond, 2001)
OWEN
BASIN
Chart / Carte 4340
GRAND
MANAN
ISLAND
Grand Harbour
Seal Cove
Swallow Tail
Northern Hd
Campobello Island
GRAND MANAN CHANNEL
EEZ/ZEE
Machais Seal
Island
Old Proprietor
Shoal
Murr Ledges
Bull Rk
Gannet Rk
North Shoal
White Hd

Fig. D.1.4. Scallop spat settling areas, and scallop and clam beds.

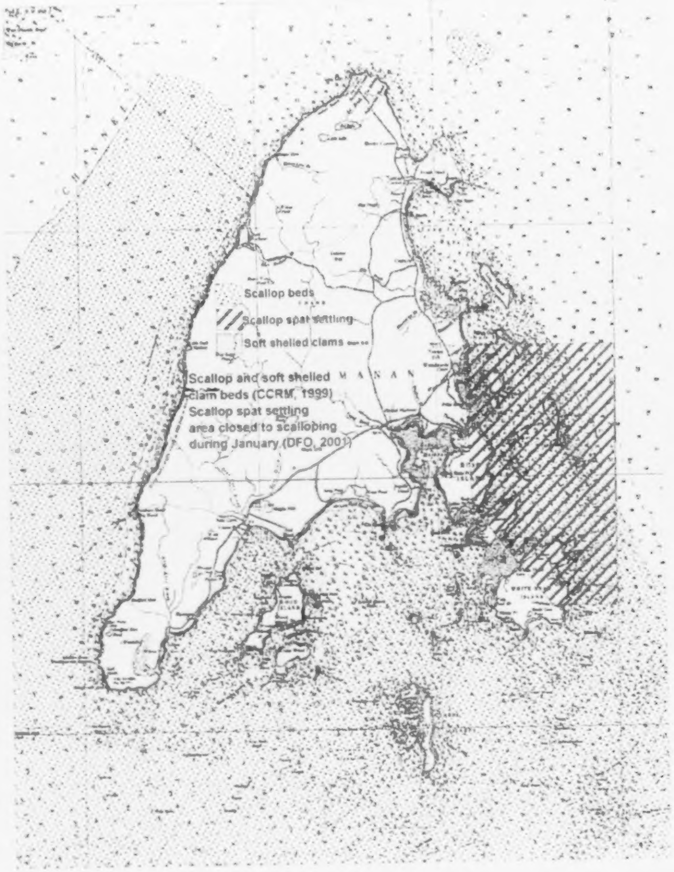

Scallop beds
Scallop spat settling
Soft shelled clams
Scallop and soft shelled clam beds (CCRM, 1999)
Scallop spat settling area closed to scalloping during January (DFO, 2001)
MANAN

Fig. D.1.5. Periwinkle and urchin fishing areas.

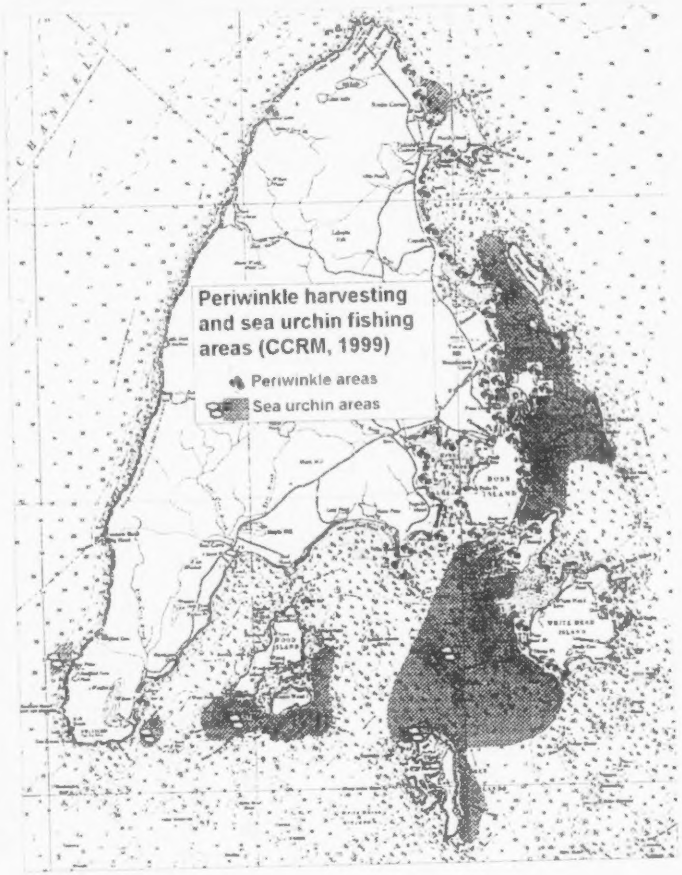

Periwinkle harvesting and sea urchin fishing areas (CCRM, 1999)
Periwinkle areas
Sea urchin areas
CHANNEL

Fig. D.1.6. Benthic species diversity as recorded by MacKay (1979).

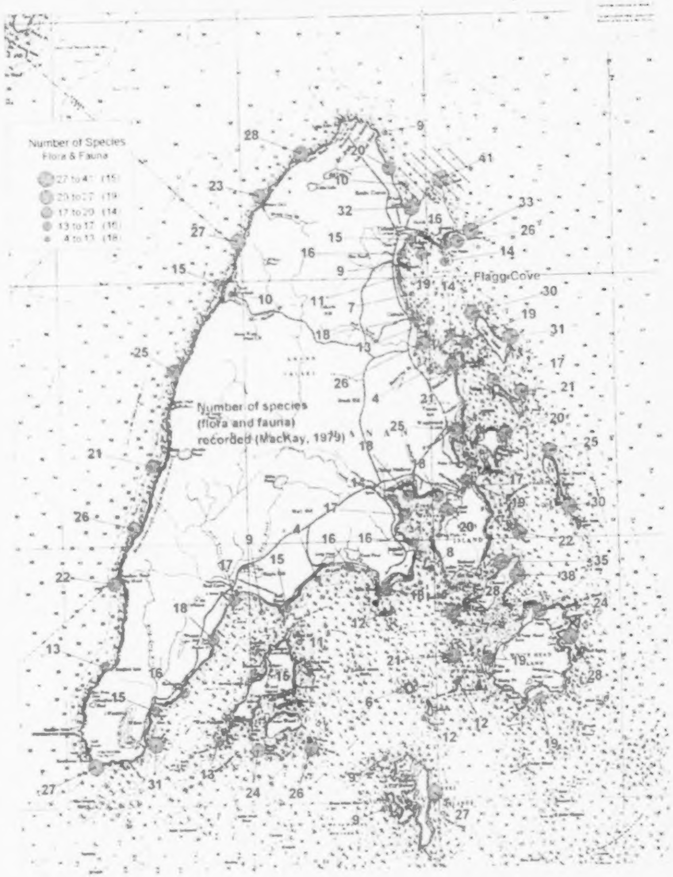

Number of Species
Flora & Fauna
27 to 41 (15)
20 to 27 (19)
17 to 20 (14)
13 to 17 (16)
4 to 13 (18)
Number of species (flora and fauna) recorded (MacKay, 1979)
Flagg Cove

Fig. D.1.7. Benthic species caught as bycatch (Kenchington, 1999).

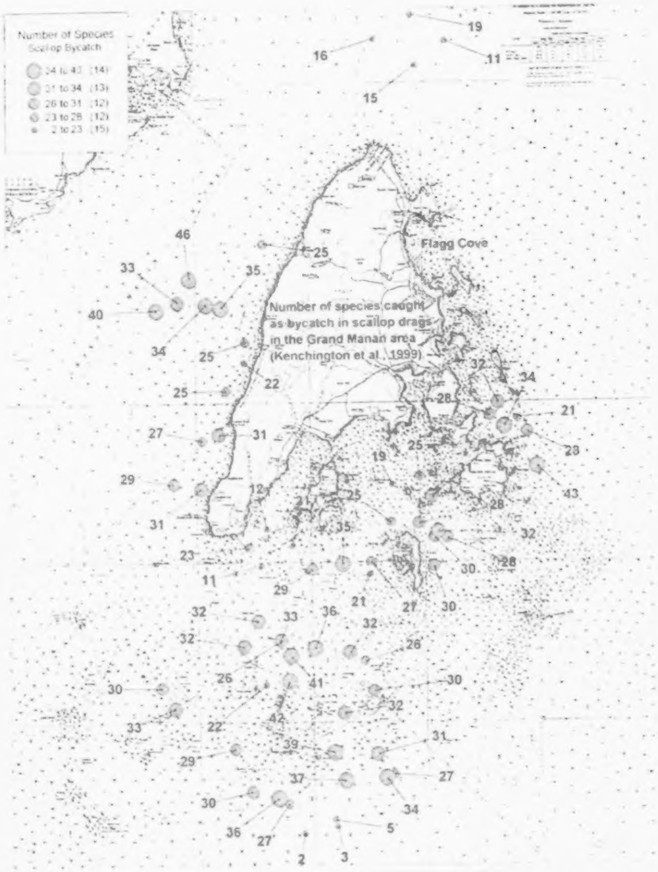

Number of Species Scallop Bycatch
34 to 43 (14)
31 to 34 (13)
26 to 31 (12)
23 to 28 (12)
2 to 23 (15)
Flagg Cove
Number of species caught as bycatch in scallop drags in the Grand Manan area (Kenchington et al. 1999)

Fig. D.1.8. Areas of Gill Net deployment and Harbour Porpoise by-catch (Trippel et al. 1996b).

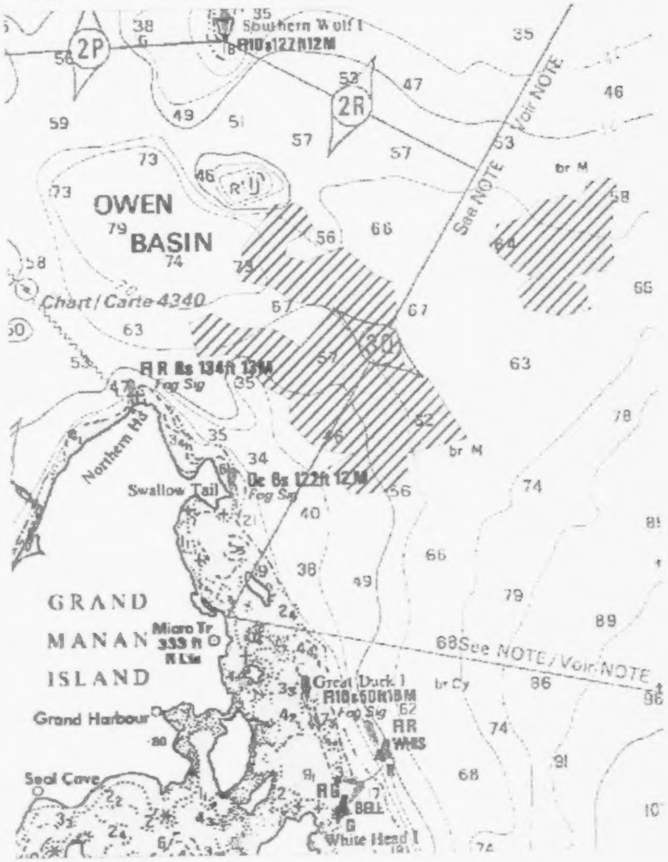

Southern Wolf I
2P
2R
OWEN BASIN
Chart / Carte 4340
Northern Hd
Swallow Tail
GRAND MANAN ISLAND
Grand Harbour
Seal Cove
Great Duck I
White Head I
See NOTE / Voir NOTE

Fig. D.1.9. Seal haulout areas (CCRM, 1999).

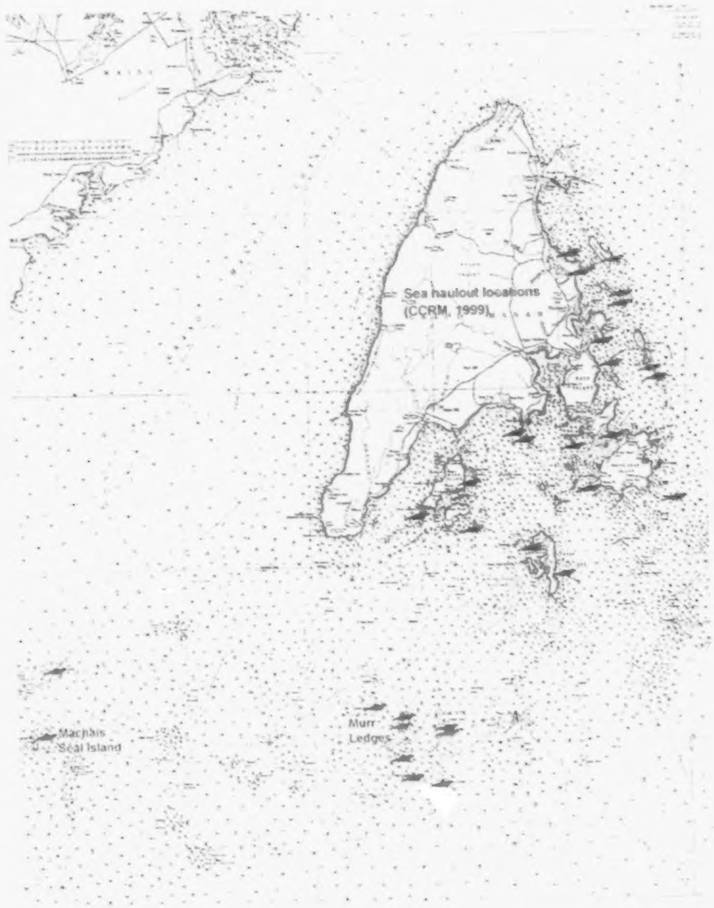

Sea haulout locations
(CCRM, 1999)
Machias
Seal Island
Murr
Ledges

Fig. D.1.10. Aquaculture sites and management areas.

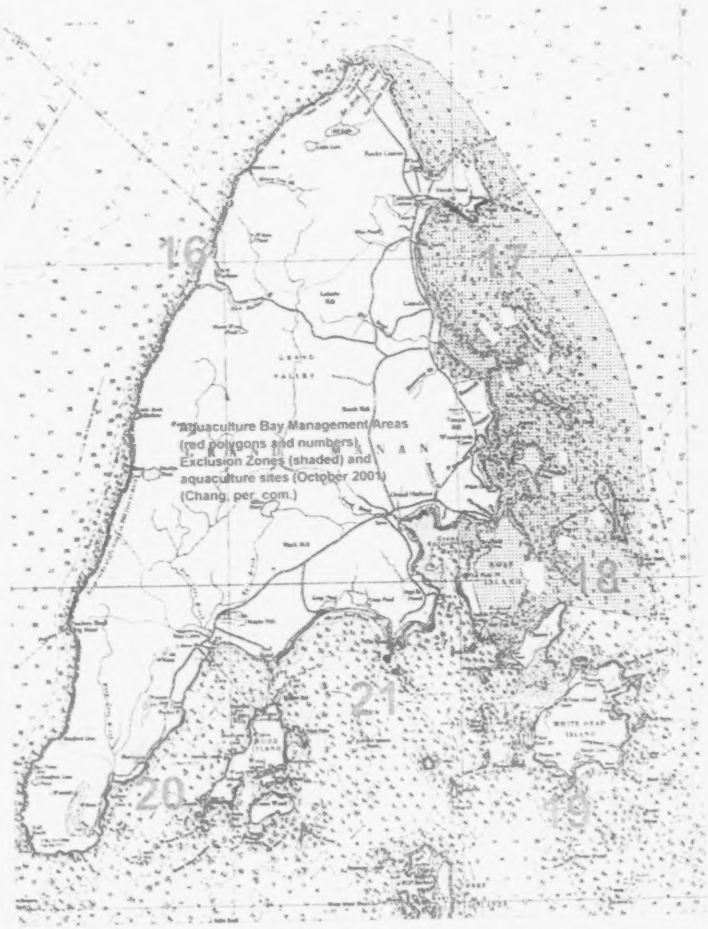

Aquaculture Bay Management Areas
(red polygons and numbers),
Exclusion Zones (shaded) and
aquaculture sites (October 2001)
(Chang, per. com.)
16
17
18
19
20
21
GRAND
VALLEY

Fig. D.1.11. Location of herring weirs, rockweed and dulse harvesting areas, and seaweed research areas.

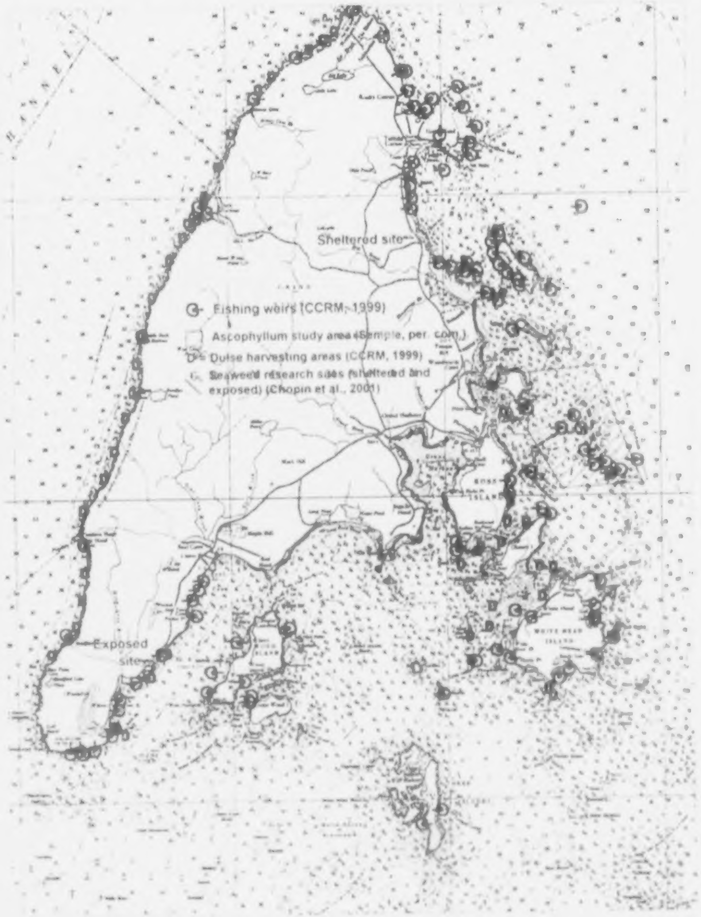

Sheltered site
Exposed site
Fishing weirs (CCRM, 1999)
Ascophyllum study area (Semple, per. com.)
Dulse harvesting areas (CCRM, 1999)
Seaweed research sites (sheltered and exposed) (Chopin et al., 2001)

Fig. D.1.12. Areas of occurrence of *Chlorophyophyta* (*Enteromorpha*, *Ulva* and *Monostroma*).

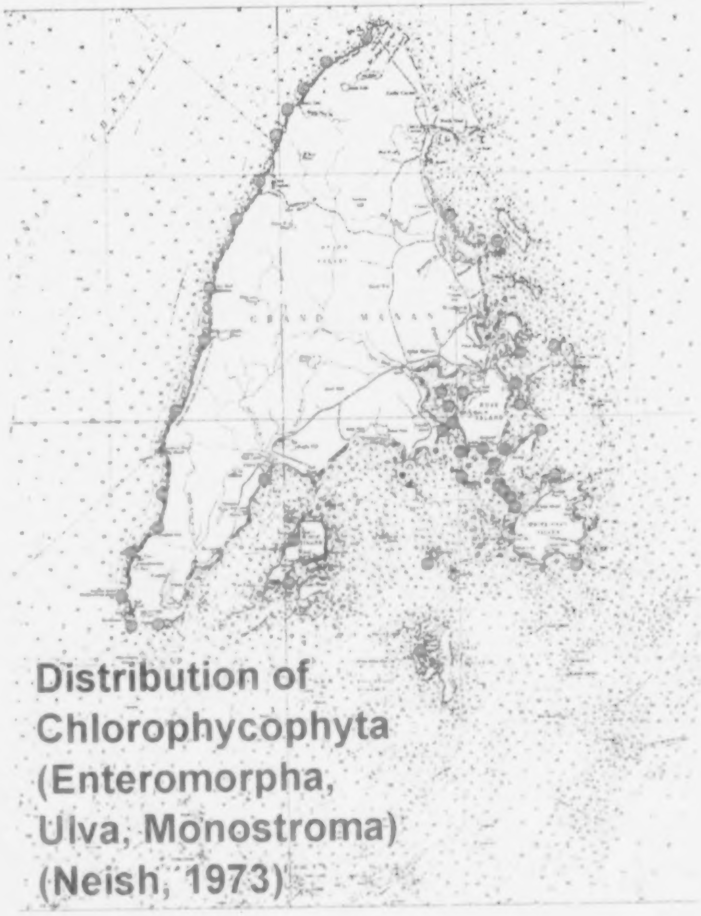

GRAND MANAN
Distribution of
Chlorophycophyta
(Enteromorpha,
Ulva, Monostroma)
(Neish, 1973)

Fig. D1.13. Areas of occurrence of *Laminariales* (*Chorda filum* and *Laminaria digitata*).

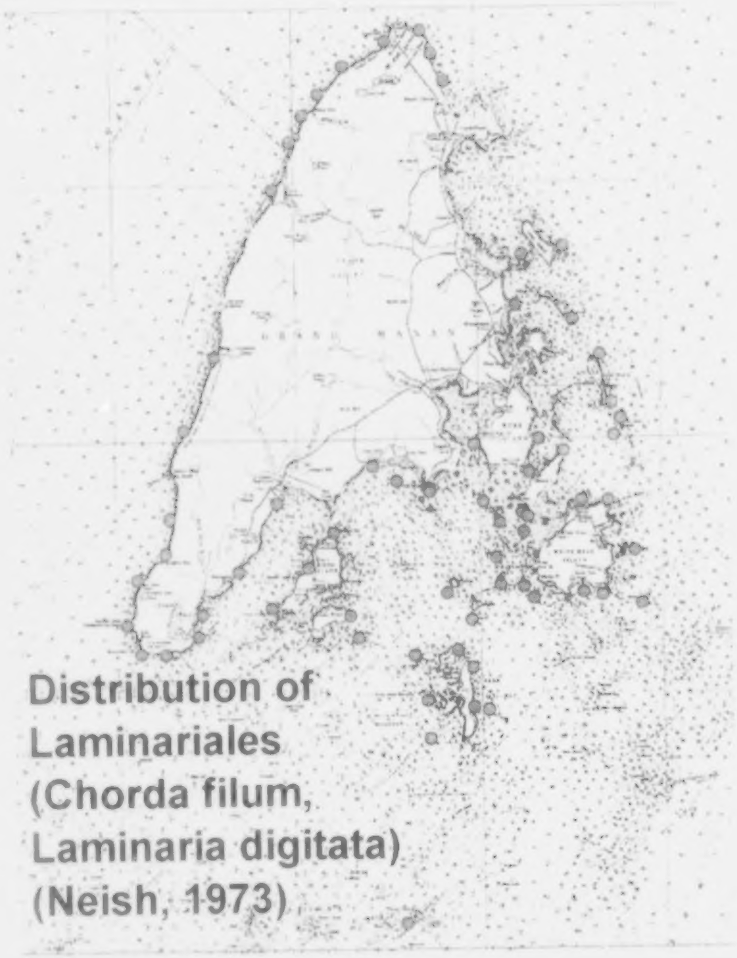

GRAND MANAN
Distribution of Laminariales (Chorda filum, Laminaria digitata) (Neish, 1973)

Fig. D1.14. Areas of occurrence of wide- frond *Laminaria longicruris*.

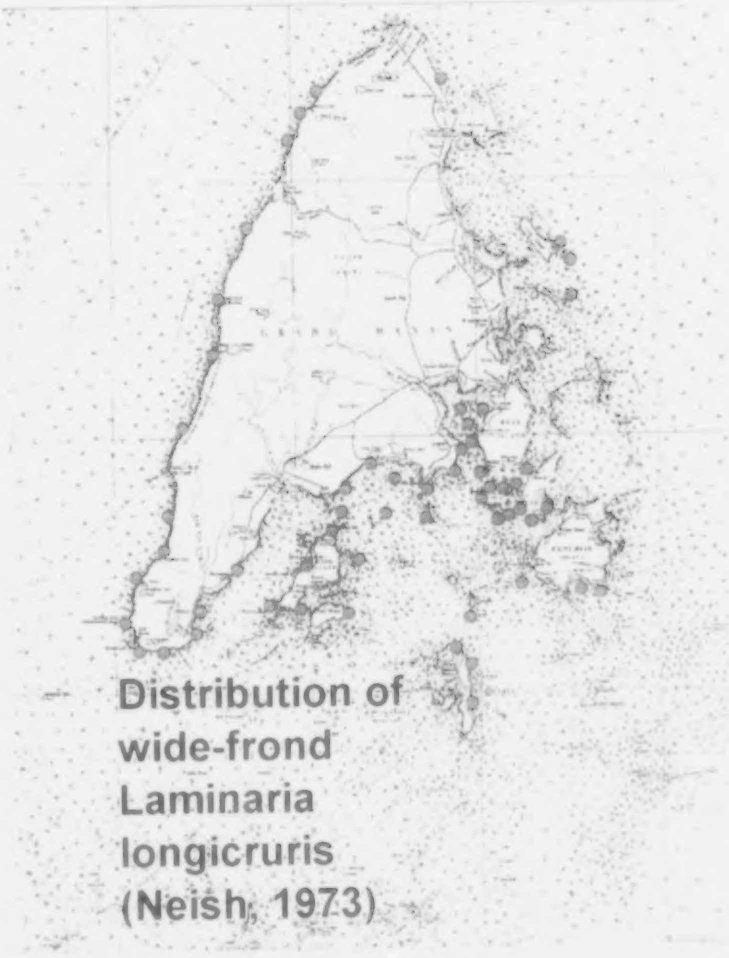

GRAND MANAN
Distribution of wide-frond Laminaria longicruris (Neish, 1973)

Fig. D.1.15. Areas of occurrence of *Porphyra*.

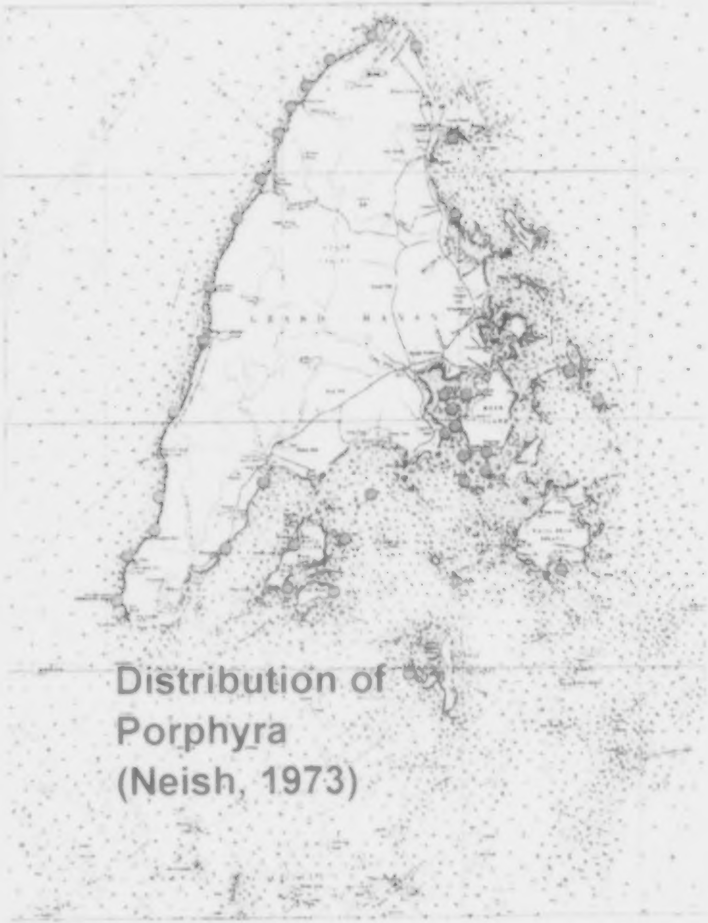

GRAND MANAN
Distribution of
Porphyra
(Neish, 1973)

Figure D.1.16. Aggregate habitat scores.

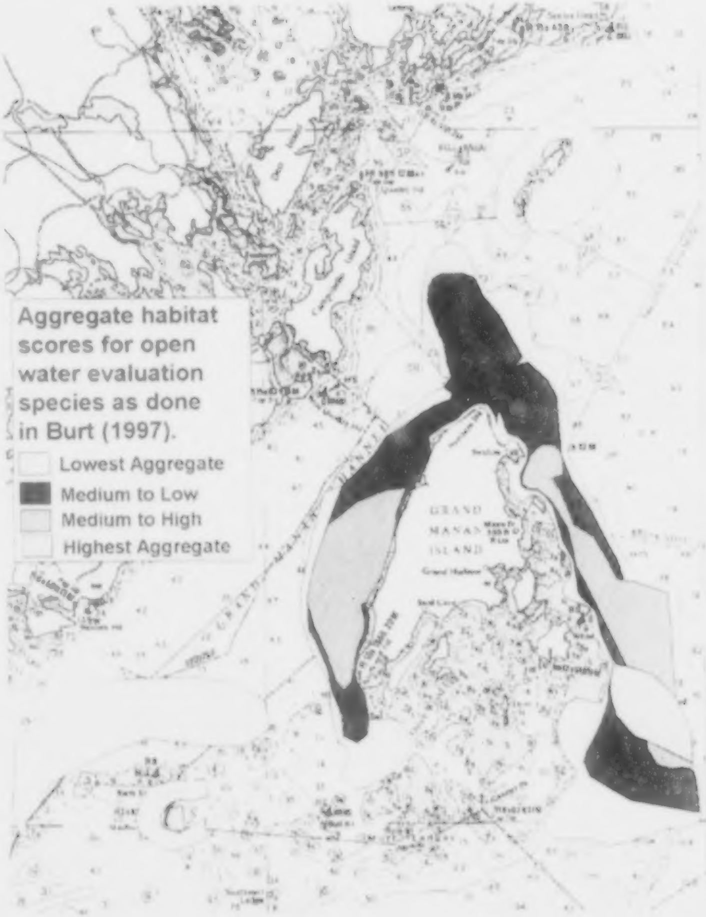
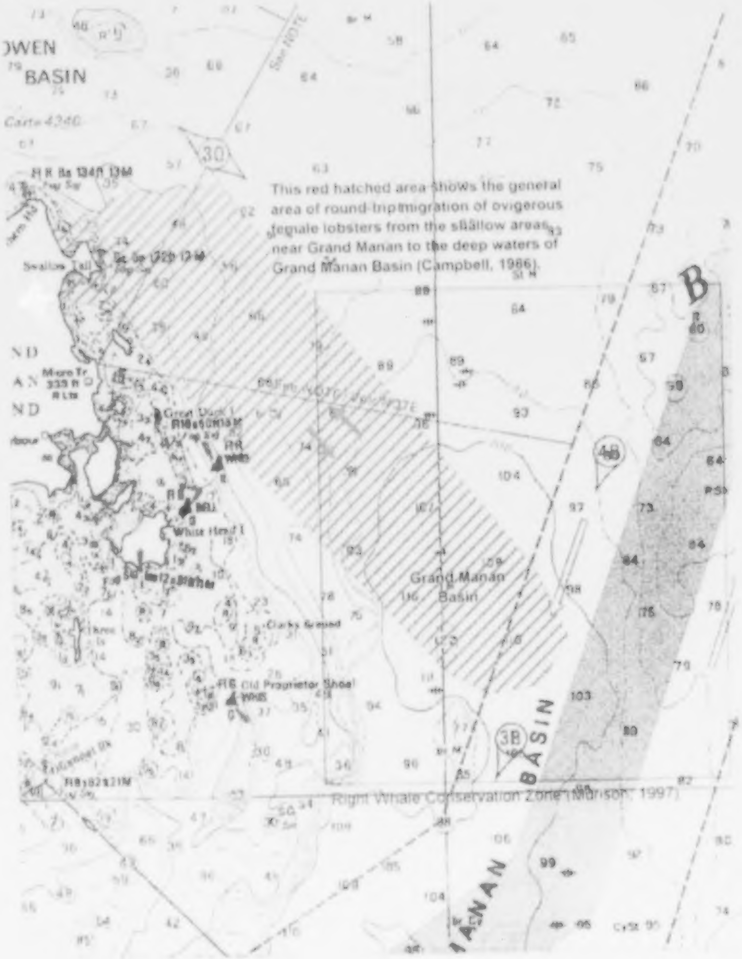

Aggregate habitat scores for open water evaluation species as done in Burt (1997).
☐ Lowest Aggregate
■ Medium to Low
▨ Medium to High
☐ Highest Aggregate
GRAND
MANAN
ISLAND

Fig. D.1.17. Right Whale Conservation area and migration area for ovigerous lobsters.

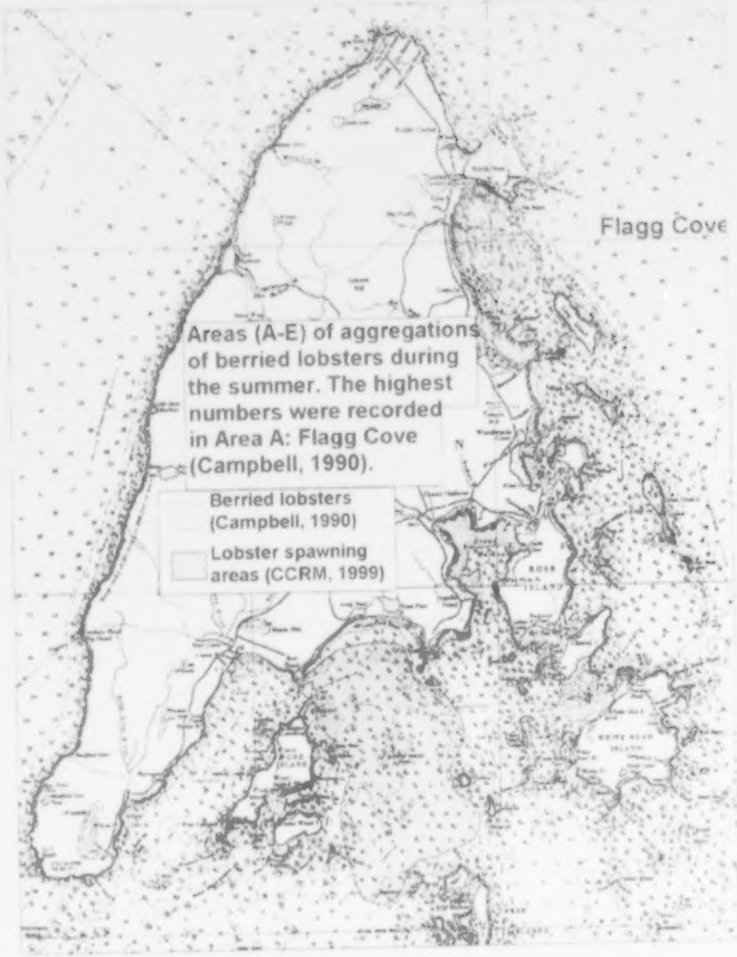


This red hatched area shows the general area of round-trip migration of ovigerous female lobsters from the shallow areas near Grand Manan to the deep waters of Grand Manan Basin (Campbell, 1986).

Right Whale Conservation Zone (Murison, 1997)

OWEN
BASIN
Carte 4246
30
B
4B
3B
Grand Manan
Basin
BASIN
MANAN
Swallow Tail
White Head I
Clarks Ground
Old Proprietor Shoal

Fig. D.1.18. Areas of aggregations of berried lobsters during summer, and areas of known lobster spawning.



Areas (A-E) of aggregations of berried lobsters during the summer. The highest numbers were recorded in Area A: Flagg Cove (Campbell, 1990).

Flagg Cove
Berried lobsters (Campbell, 1990)
Lobster spawning areas (CCRM, 1999)

Fig. D.2.1. The Quoddy Region.

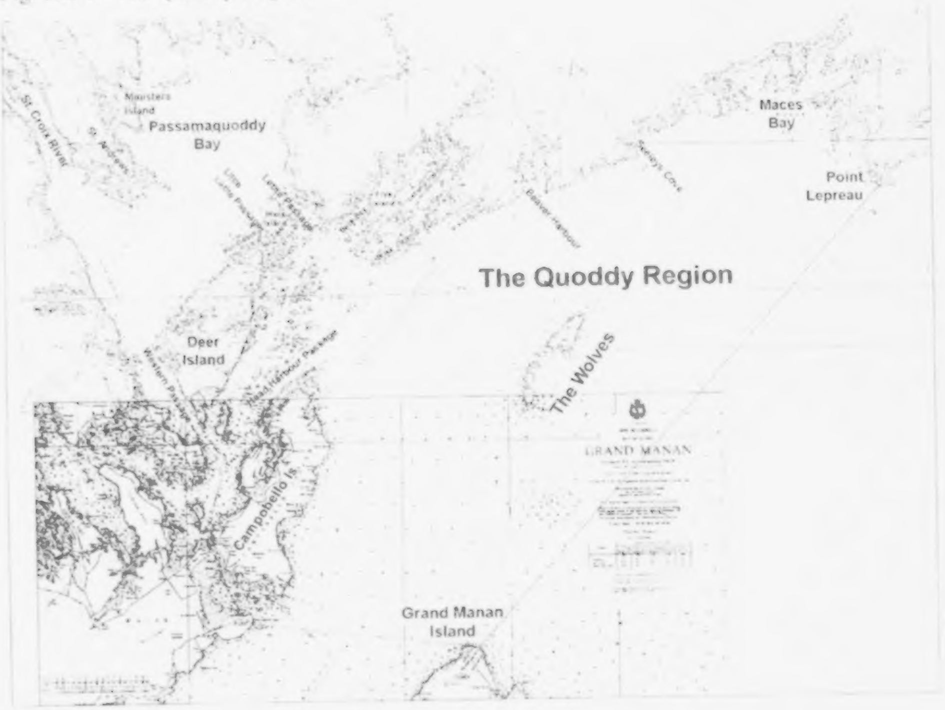

St Croix River
Maisters Island
St Andrews
Passamaquoddy Bay
Letite Passage
Beaver Harbour
Seeleys Cove
Maces Bay
Point Lepreau
The Quoddy Region
Deer Island
Western Passage
Head Harbour Passage
The Wolves
Campobello Is
GRAND MANAN
Grand Manan Island

Fig. D.2.2. Circulation in the Quoddy Region.

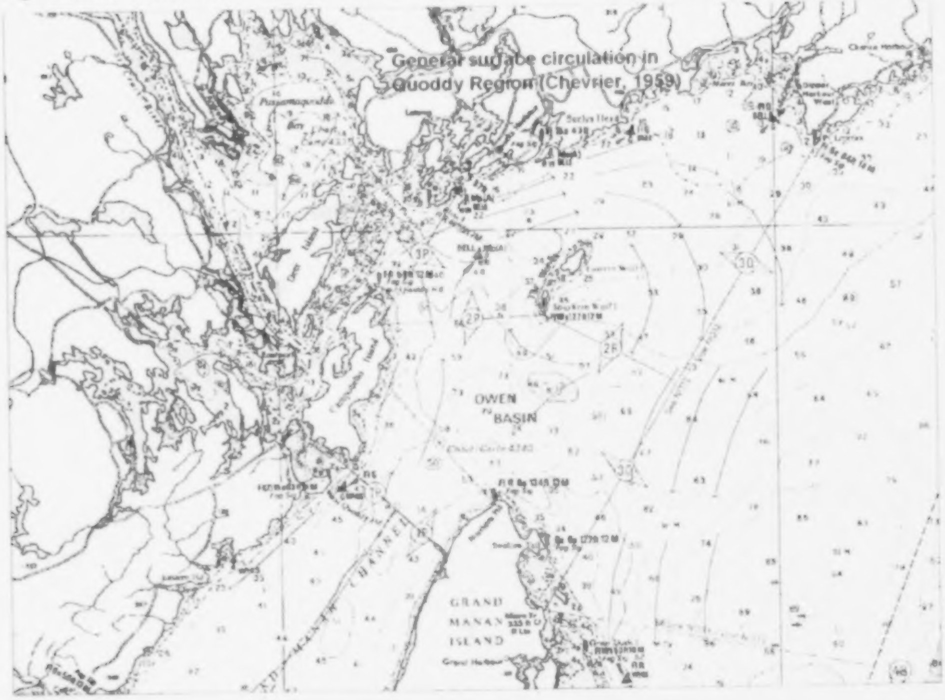

General surface circulation in Quoddy Region (Chevrier, 1959)
Passamaquoddy Bay
Deer Island
Campobello Island
OWEN BASIN
GRAND MANAN ISLAND
Grand Harbour

Fig. D.2.3. Passamaquoddy Bay locations.

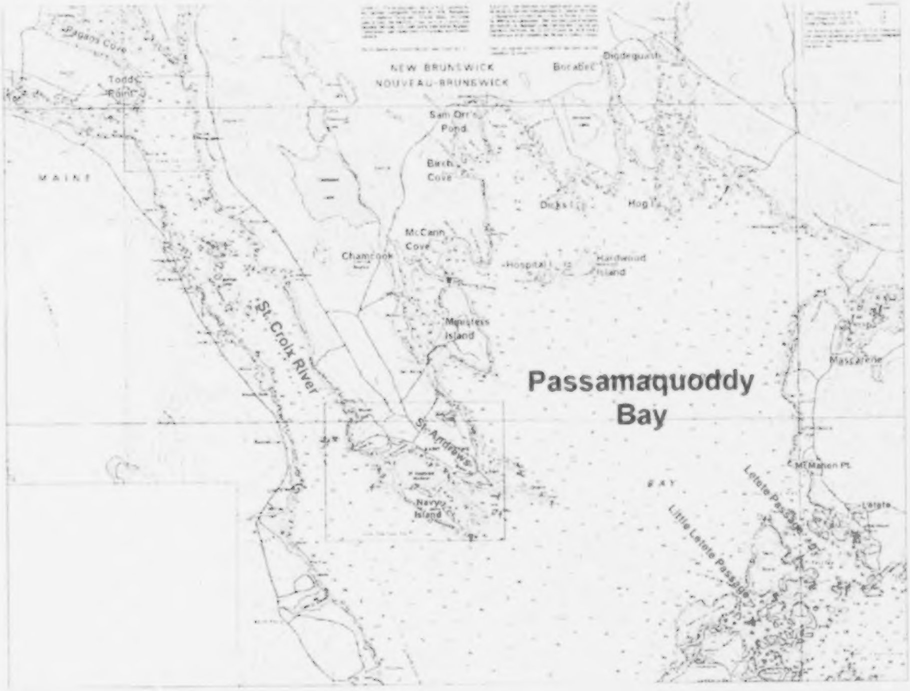

Pagans Cove
Todds Point
MAINE
NEW BRUNSWICK
NOUVEAU-BRUNSWICK
Bocabec
Digdeguash
Sam Orr's Pond
Birch Cove
Dicks I.
Hog I.
McCann Cove
Chamcook
Hospital I.
Hardwood Island
Ministers Island
St. Croix River
Passamaquoddy Bay
St. Andrews
Navy Island
Mascarene
BAY
McMahon Pt.
Letete Passage
Little Letete Passage
Letete

Fig. D.2.4. Shoreline Classification of Passamaquoddy Bay (CCRM, 1999).

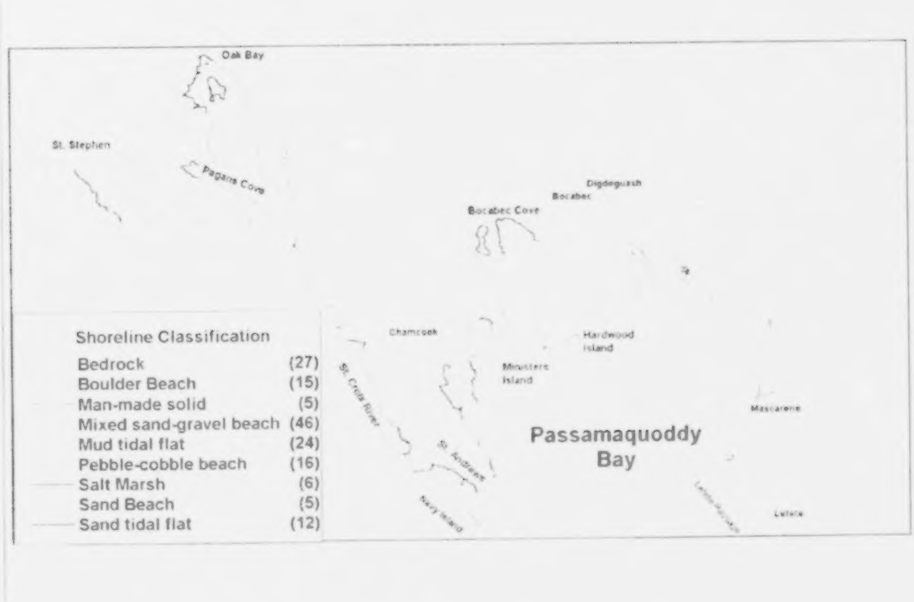

Oak Bay
St. Stephen
Pagans Cove
Digdeguash
Bocabec
Bocabec Cove
Chamcook
Hardwood Island
Ministers Island
St. Croix River
St. Andrews
Navy Island
Passamaquoddy Bay
Mascarene
Letete Passage
Letete
Shoreline Classification
Bedrock (27)
Boulder Beach (15)
Man-made solid (5)
Mixed sand-gravel beach (46)
Mud tidal flat (24)
Pebble-cobble beach (16)
Salt Marsh (6)
Sand Beach (5)
Sand tidal flat (12)

Fig. D.2.5. Scallop beds and soft shelled clam beds.

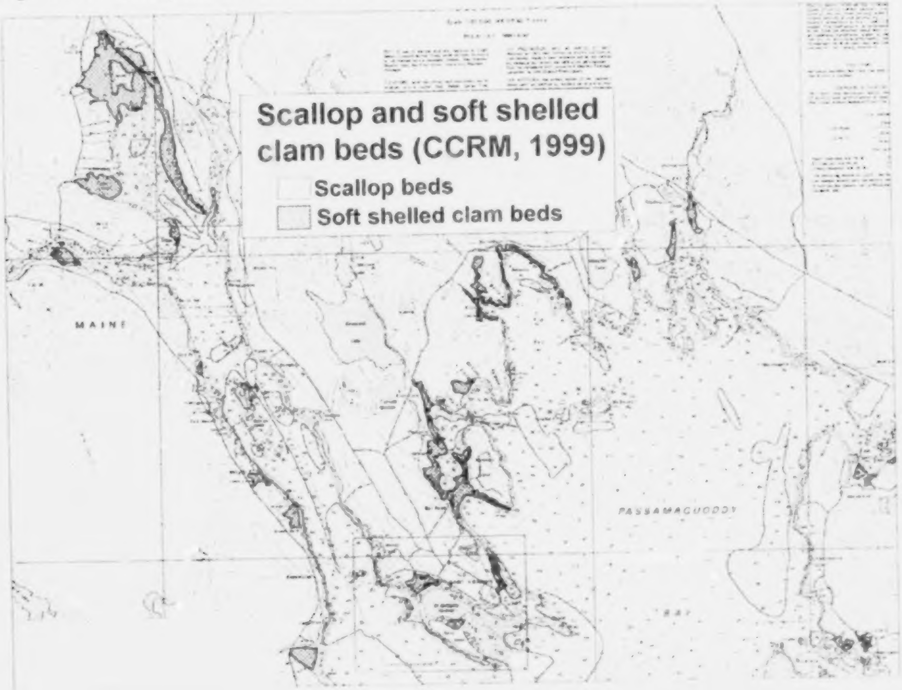

Scallop and soft shelled clam beds (CCRM, 1999)
Scallop beds
▨ Soft shelled clam beds
MAINE
PASSAMAQUODDY
BAY

Fig. D.2.6. Lobster abundance determined by transects and collection dives.

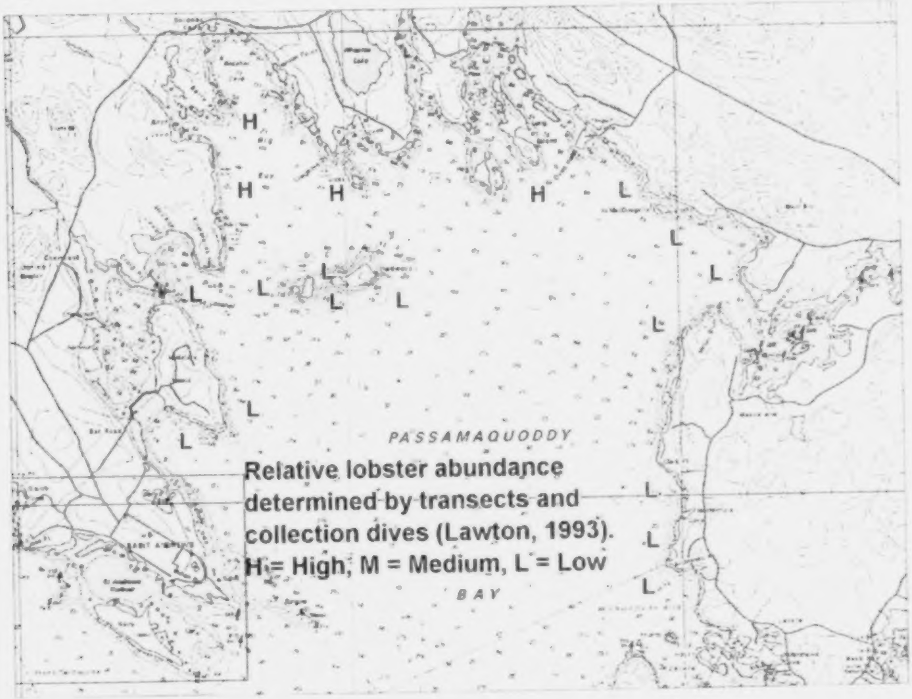

H
H
H
H
L
L
L
L
L
L
L
L
L
L
L
L
L
L
PASSAMAQUODDY
Relative lobster abundance determined by transects and collection dives (Lawton, 1993).
H = High, M = Medium, L = Low
BAY

Fig. D.2.7. Number of Species recorded by MacKay (1978).

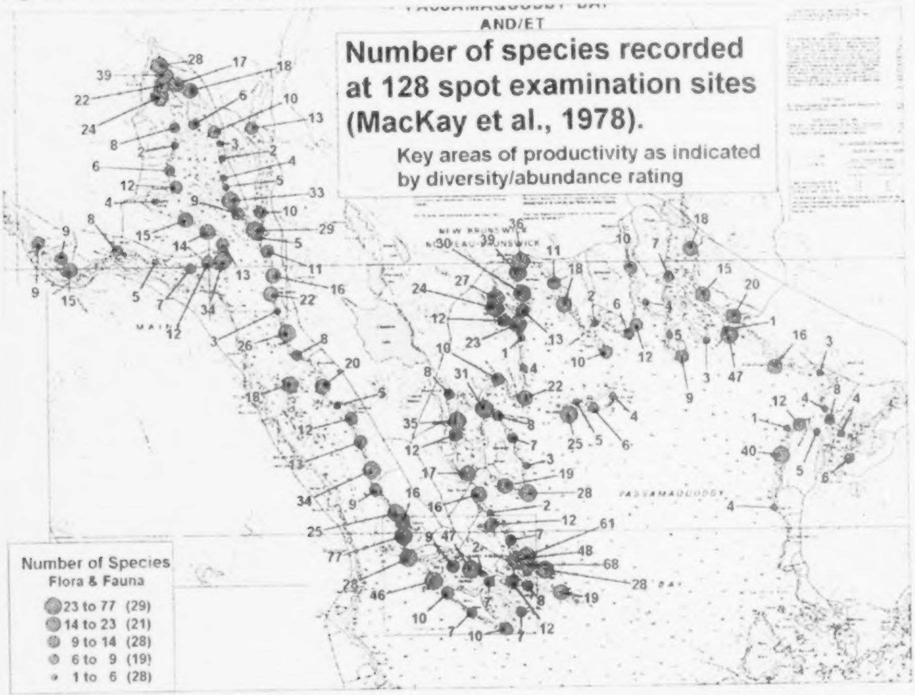

AND/ET
Number of species recorded at 128 spot examination sites (MacKay et al., 1978).
Key areas of productivity as indicated by diversity/abundance rating
NEW BRUNSWICK
NOUVEAU-BRUNSWICK
MAINE
PASSAMAQUODDY
BAY
Number of Species
Flora & Fauna
23 to 77 (29)
14 to 23 (21)
9 to 14 (28)
6 to 9 (19)
1 to 6 (28)

Fig. D.2.8. Sea cucumber fishing areas, seal haulouts, and seaweed locations.

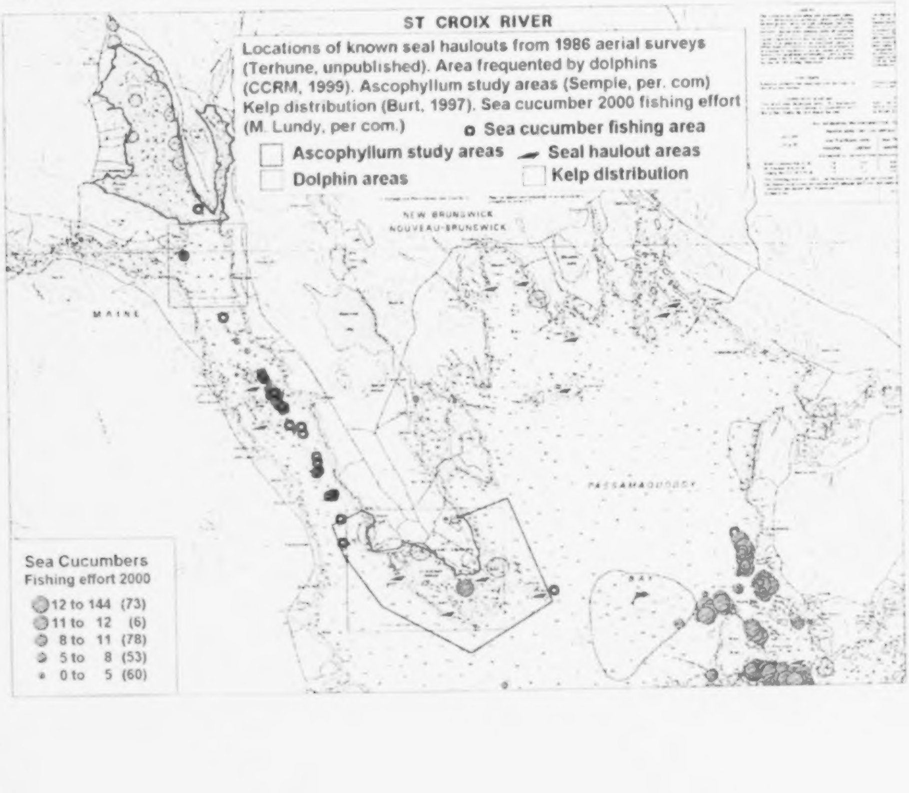
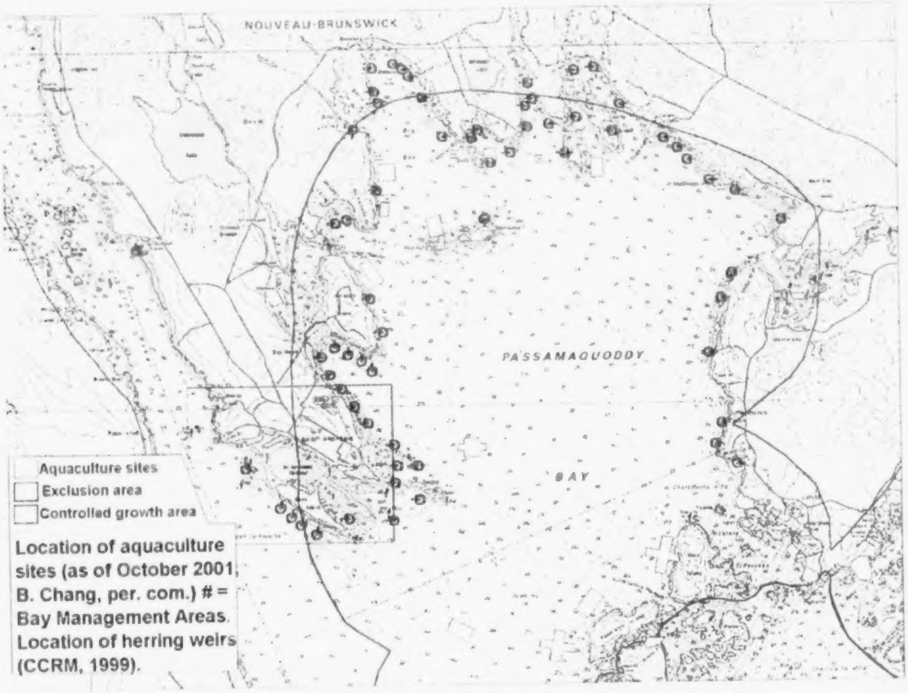

ST CROIX RIVER
Locations of known seal haulouts from 1986 aerial surveys (Terhune, unpublished). Area frequented by dolphins (CCRM, 1999). Ascophyllum study areas (Semple, per. com) Kelp distribution (Burt, 1997). Sea cucumber 2000 fishing effort (M. Lundy, per com.)
Sea cucumber fishing area
Ascophyllum study areas
Seal haulout areas
Dolphin areas
Kelp distribution
NEW BRUNSWICK
NOUVEAU-BRUNSWICK
MAINE
PASSAMAQUODDY
BAY
Sea Cucumbers
Fishing effort 2000
12 to 144 (73)
11 to 12 (6)
8 to 11 (78)
5 to 8 (53)
0 to 5 (60)

Fig. D.2.9. Aquaculture sites and location of herring weirs.


NOUVEAU-BRUNSWICK
PASSAMAQUODDY
BAY
Aquaculture sites
Exclusion area
Controlled growth area

Location of aquaculture sites (as of October 2001, B. Chang, per. com.) # = Bay Management Areas. Location of herring weirs (CCRM, 1999).

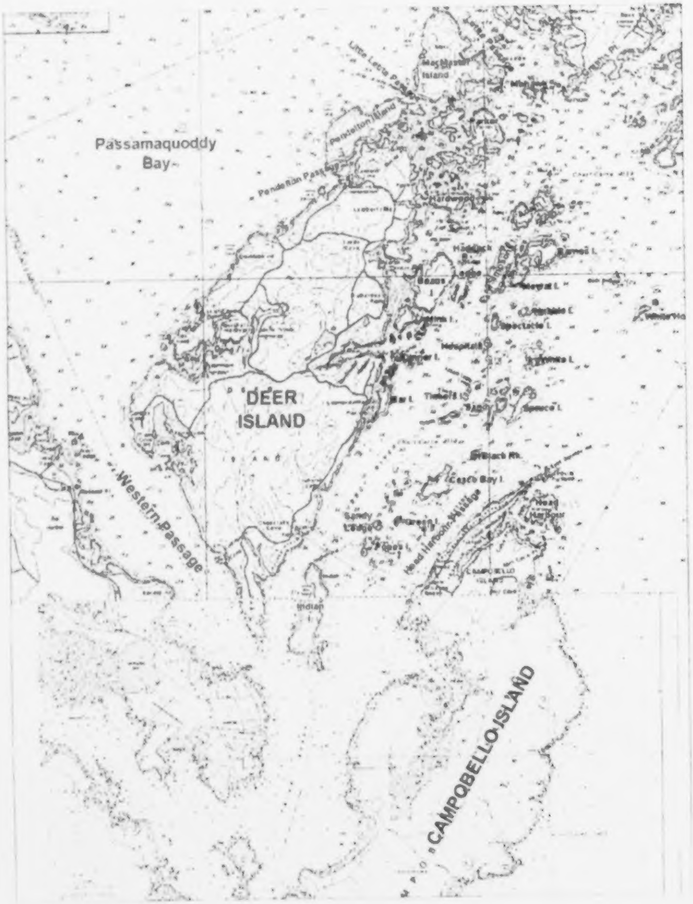


Fig. D.2.10. Deer Island. Campobello and surrounding area.

Passamaquoddy
Bay
DEER
ISLAND
Western Passage
Little Letite Passage
Pendleton Passage
Head Harbour Passage
CAMPOBELLO ISLAND

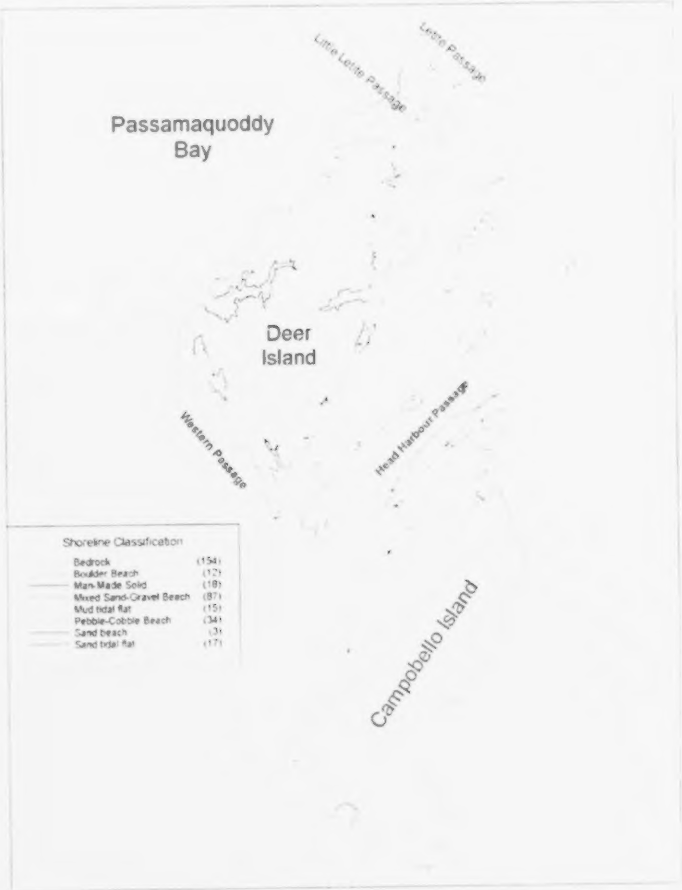


Fig. D.2.11. Shoreline classification in the Deer Island - Campobello Island Area (CCRM, 1999).

Passamaquoddy
Bay
Little Letite Passage
Letite Passage
Deer
Island
Western Passage
Head Harbour Passage
Campobello Island
Shoreline Classification
Bedrock (154)
Boulder Beach (12)
Man-Made Solid (18)
Mixed Sand-Gravel Beach (87)
Mud tidal flat (15)
Pebble-Cobble Beach (34)
Sand beach (3)
Sand tidal flat (17)

Fig. D.2.12. Marine mammal distributions in the West Isles.

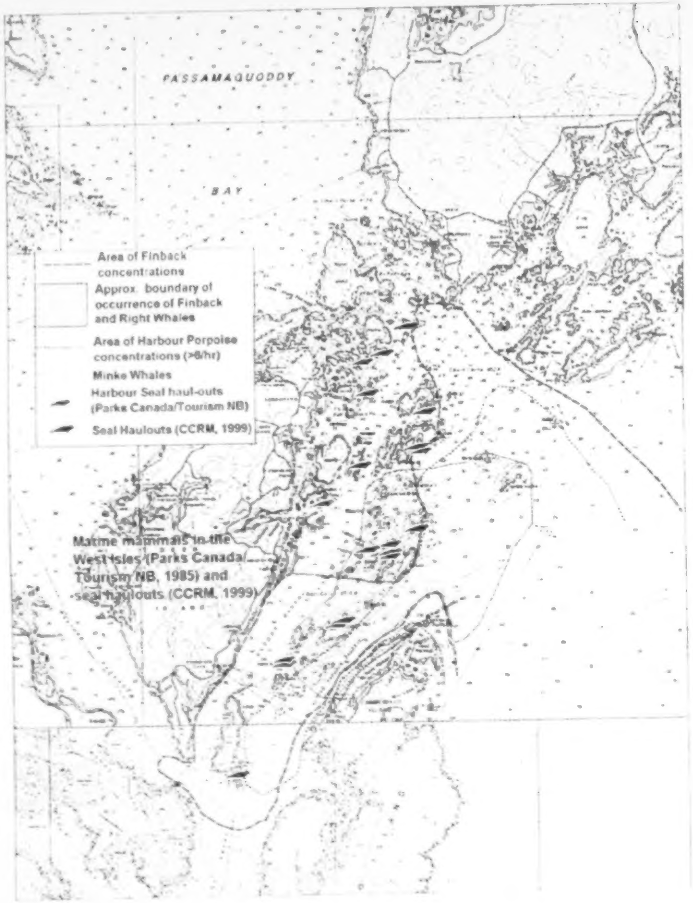

PASSAMAQUODDY
BAY
Area of Finback concentrations
Approx. boundary of occurrence of Finback and Right Whales
Area of Harbour Porpoise concentrations (>6/hr)
Minke Whales
Harbour Seal haul-outs (Parks Canada/Tourism NB)
Seal Haulouts (CCRM, 1999)
Marine mammals in the West Isles (Parks Canada/Tourism NB, 1985) and seal haulouts (CCRM, 1999)

Fig. D.2.13. Finback whale movement, and seal haulouts in the West Isles.

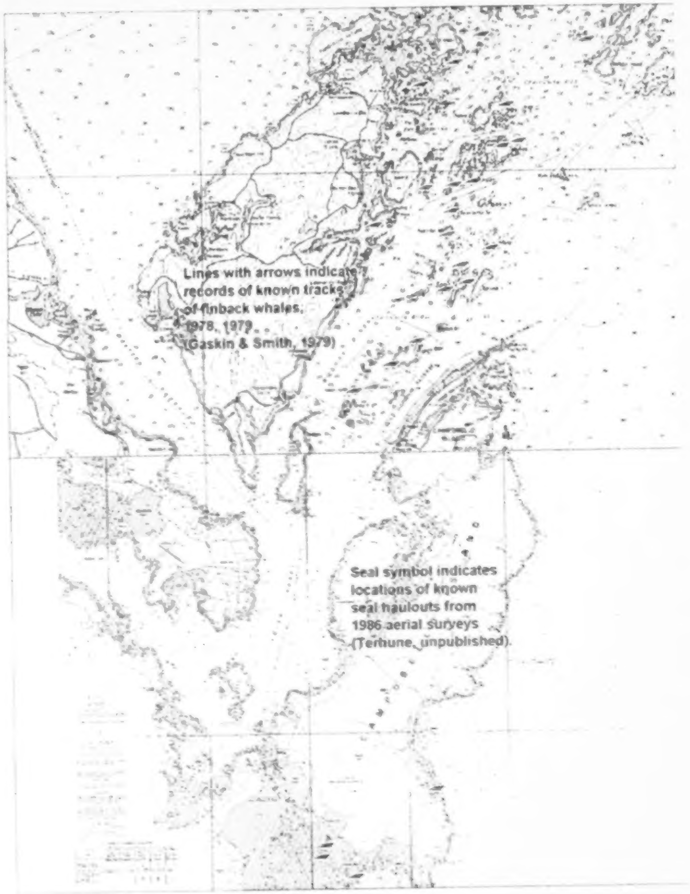
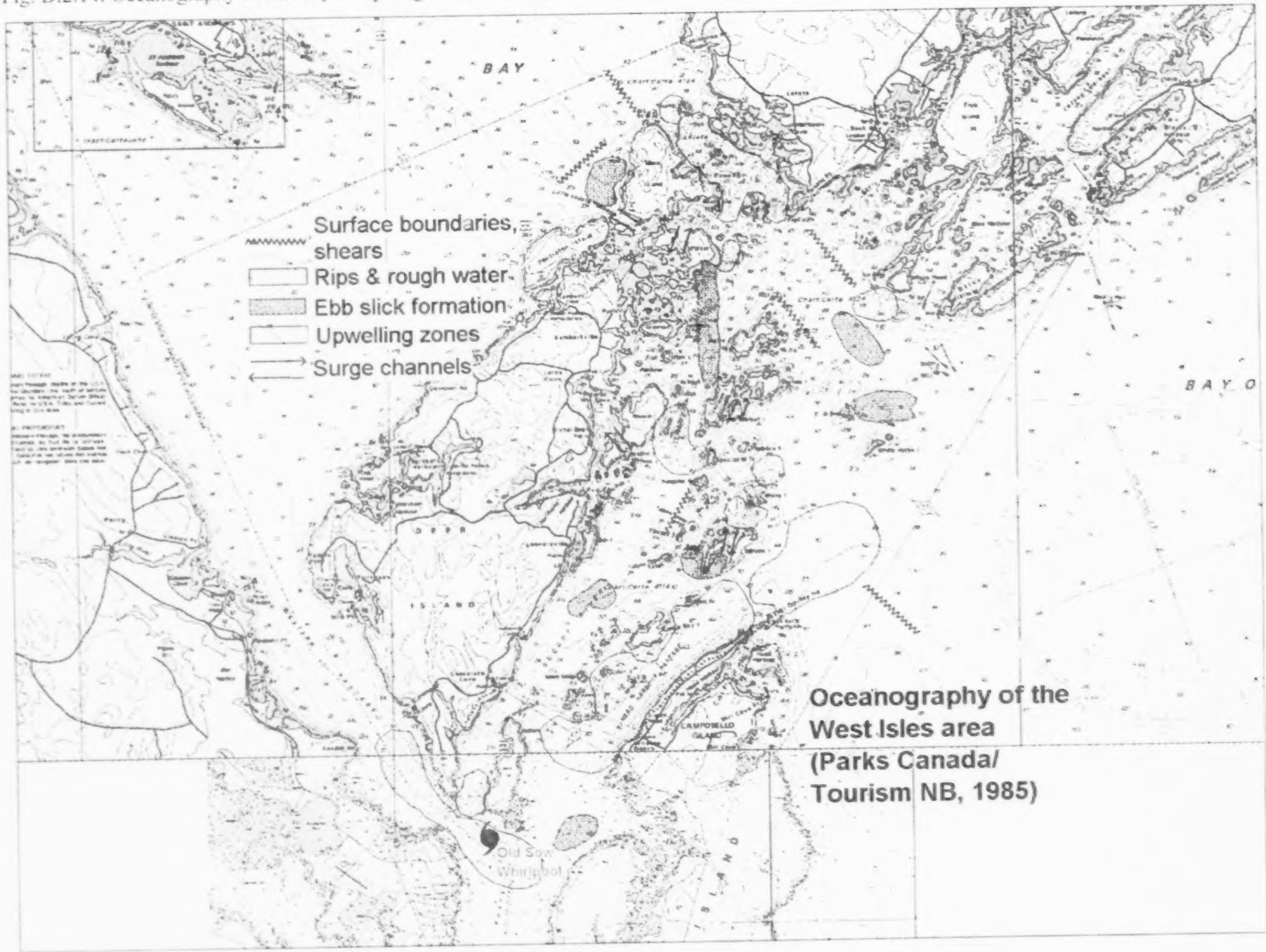

Lines with arrows indicate records of known tracks of finback whales, 1978, 1979 (Gaskin & Smith, 1979)
Seal symbol indicates locations of known seal haulouts from 1986 aerial surveys (Terhune, unpublished).

Fig. D.2.14. Oceanography in outer Quoddy Region (West Isles).


BAY
BAY O
Surface boundaries, shears
Rips & rough water
Ebb slick formation
Upwelling zones
Surge channels
DEER ISLAND
CAMPOBELLO ISLAND
Old Sow Whirlpool

Oceanography of the West Isles area (Parks Canada/ Tourism NB, 1985)

Fig. D.2.15. Marine and shorebird nesting and feeding areas in the West Isles

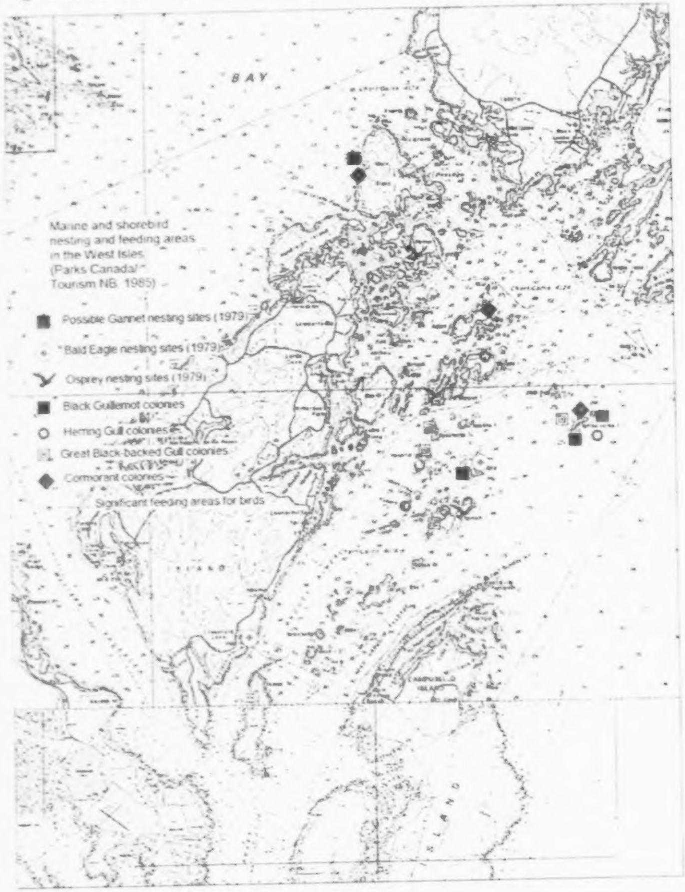

BAY
Marine and shorebird
nesting and feeding areas
in the West Isles
(Parks Canada/
Tourism NB. 1985)
■ Possible Gannet nesting sites (1979)
Bald Eagle nesting sites (1979)
Osprey nesting sites (1979)
■ Black Guillemot colonies
○ Herring Gull colonies
▨ Great Black-backed Gull colonies
◆ Cormorant colonies
Significant feeding areas for birds

Fig. D.2.16. Sightings of mother-calf pairs of harbour porpoise.

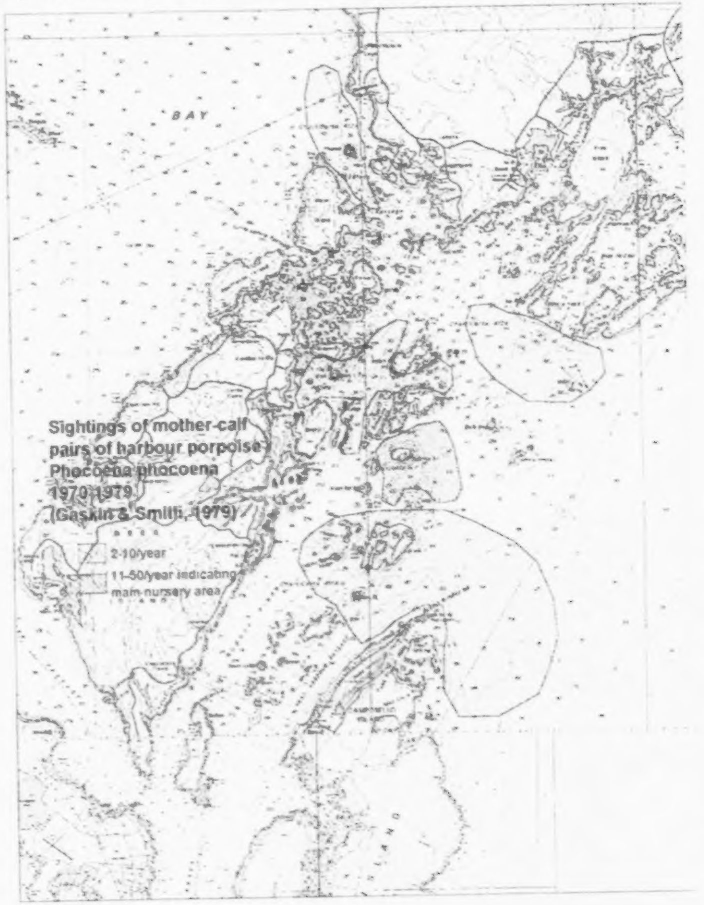

BAY
Sightings of mother-calf
pairs of harbour porpoise
Phocoena phocoena
1970-1979
(Gaskin & Smith, 1979)
2-10/year
11-50/year indicating
main nursery area

Fig. D.2.17. High (H) and medium (M) abundances of harbour porpoise.

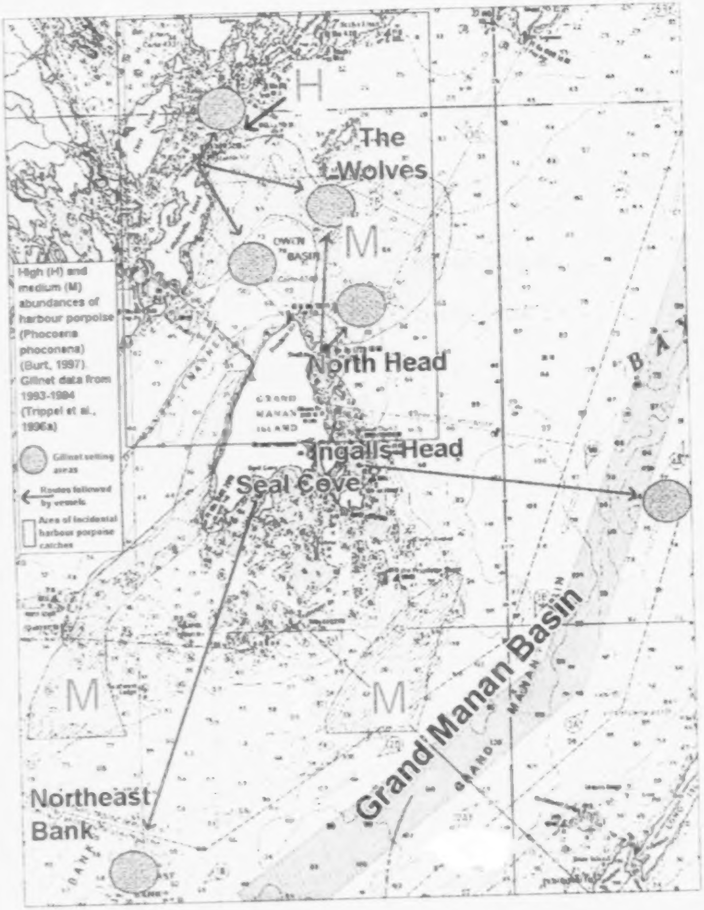

H
The Wolves
M
North Head
Ingalls Head
Seal Cove
M
M
Grand Manan Basin
Northeast Bank
High (H) and medium (M) abundances of harbour porpoise (Phocoena phoconena) (Burt, 1997). Gillnet data from 1993-1994 (Trippel et al., 1996a)
Gillnet setting areas
Routes followed by vessels
Area of incidental harbour porpoise catches

Fig. D.2.18. Kelp distribution, dulse and periwinkle harvesting areas. Sea Cucumber harvesting areas.

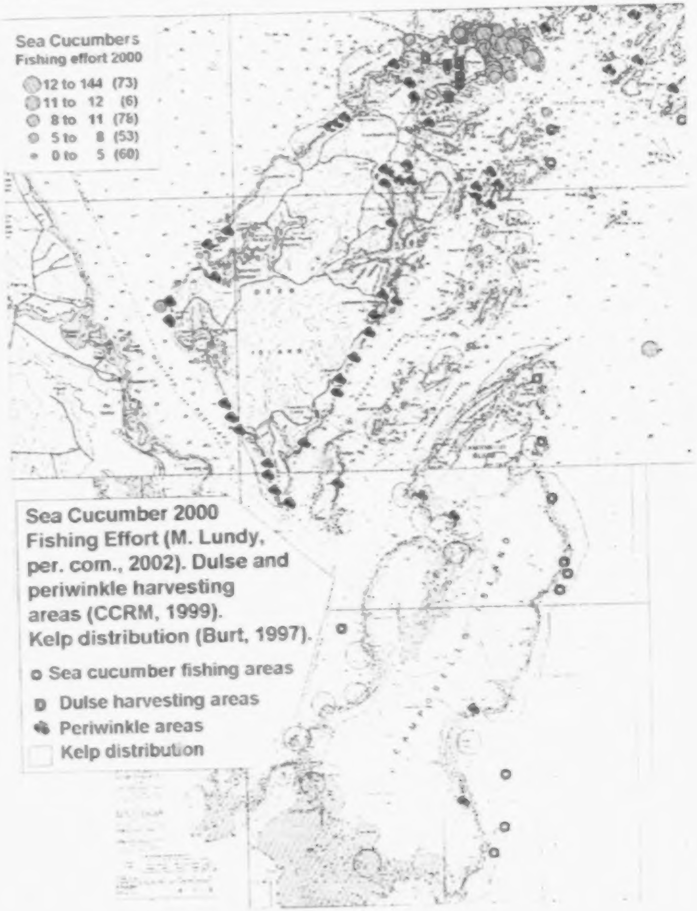

Sea Cucumbers
Fishing effort 2000
12 to 144 (73)
11 to 12 (6)
8 to 11 (76)
5 to 8 (53)
0 to 5 (60)
Sea Cucumber 2000 Fishing Effort (M. Lundy, per. com., 2002). Dulse and periwinkle harvesting areas (CCRM, 1999). Kelp distribution (Burt, 1997).
Sea cucumber fishing areas
Dulse harvesting areas
Periwinkle areas
Kelp distribution

Fig. D.2.19. Mean *Ascophyllum* wet weight at sites sampled during 1989-90 and study site. Scallop and soft shelled clam beds.

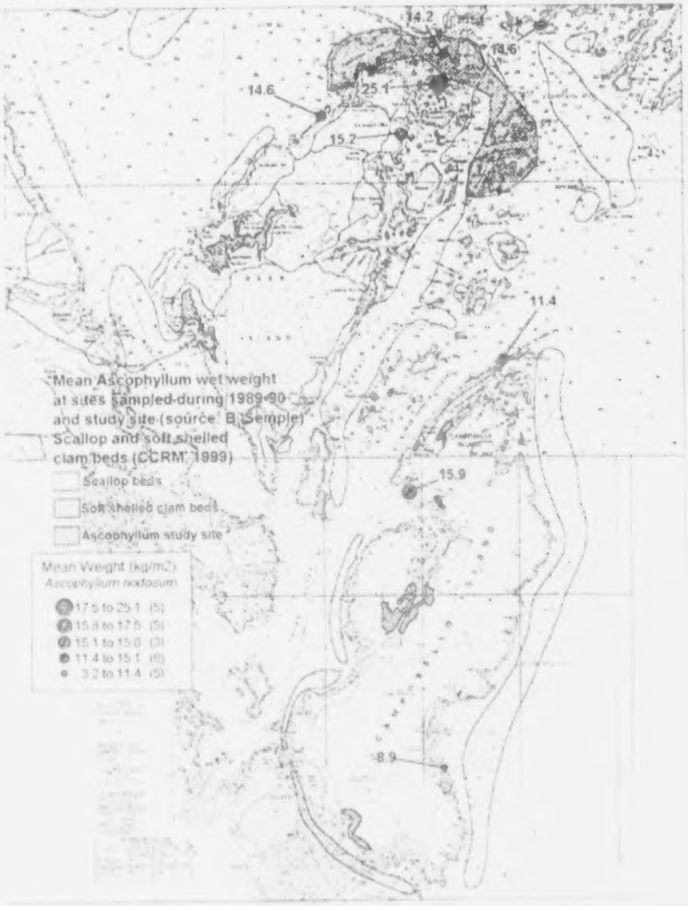

14.2
14.6
25.1
14.6
15.2
11.4
15.9
8.9
Mean Ascophyllum wet weight at sites sampled during 1989-90 and study site (source: B. Semple)
Scallop and soft shelled clam beds (CCRM, 1999)
Scallop beds
Soft shelled clam beds
Ascophyllum study site
Mean Weight (kg/m2)
Ascophyllum nodosum
17.5 to 25.1 (5)
15.8 to 17.5 (5)
15.1 to 15.8 (3)
11.4 to 15.1 (6)
3.2 to 11.4 (5)

Fig. D.2.20. Relative lobster abundance determined by transects and collection.

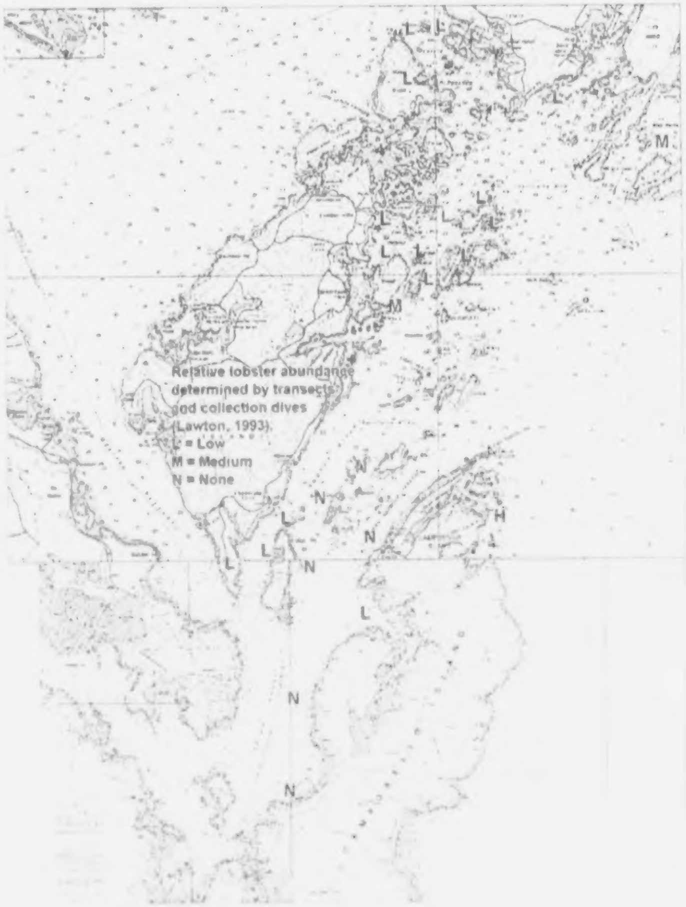

Relative lobster abundance determined by transects and collection dives (Lawton, 1993).
L = Low
M = Medium
N = None

Fig. D.2.21. Location of aquaculture sites and herring weirs

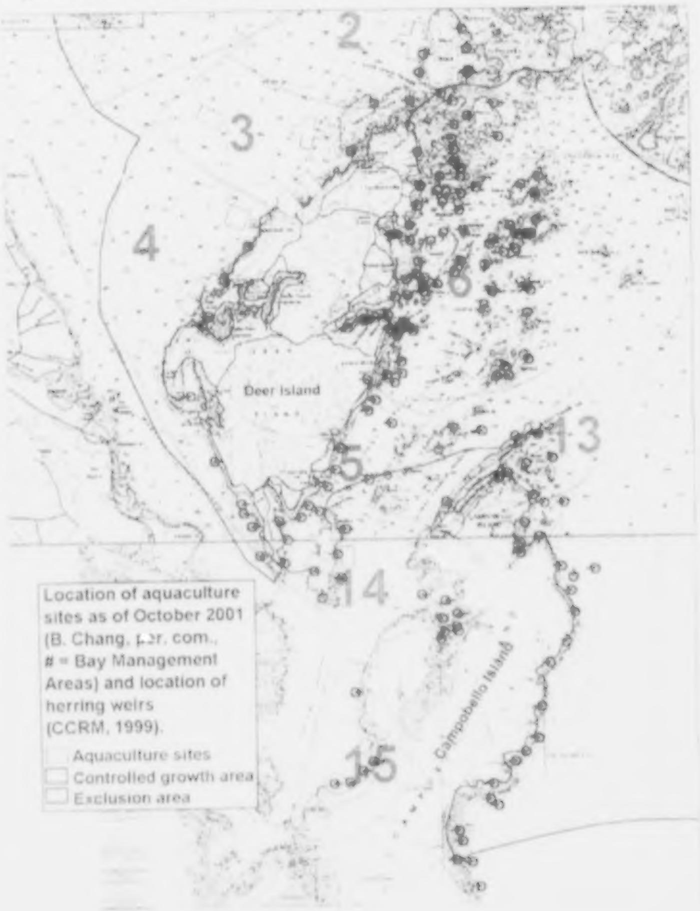

2
3
4
5
6
13
14
15
Deer Island
Campobello Island
Location of aquaculture sites as of October 2001 (B. Chang, per. com., # = Bay Management Areas) and location of herring weirs (CCRM, 1999).
Aquaculture sites
Controlled growth area
Exclusion area

Fig. D.2.22. Number of species (flora and fauna) recorded by MacKay et al.

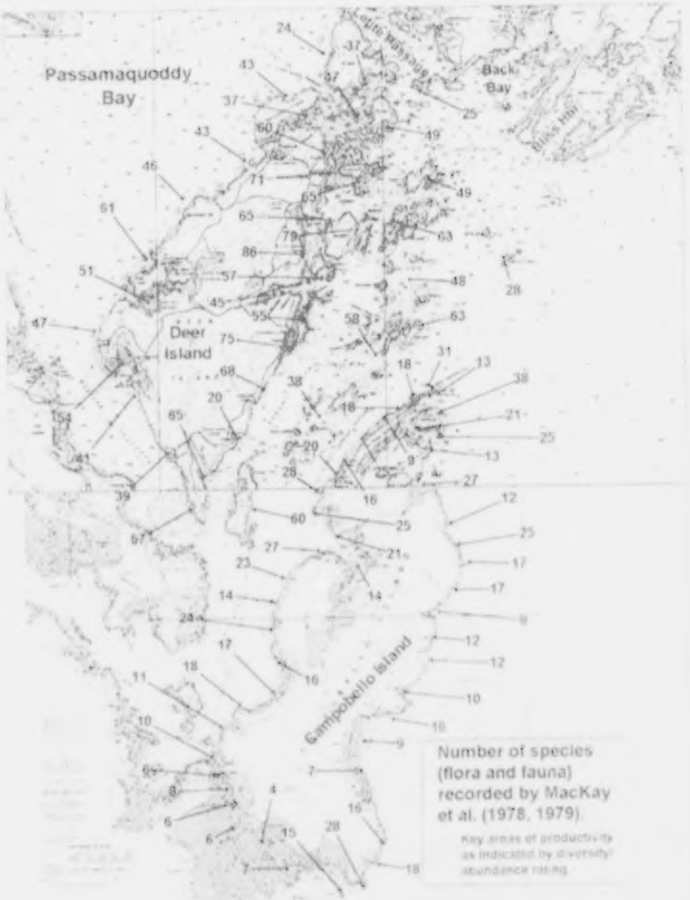

Passamaquoddy Bay
Deer Island
Back Bay
Campobello Island
Number of species (flora and fauna) recorded by MacKay et al. (1978, 1979).
Key areas of productivity as indicated by diversity/ abundance rating

Fig. D.2.23. Distribution of indicator species

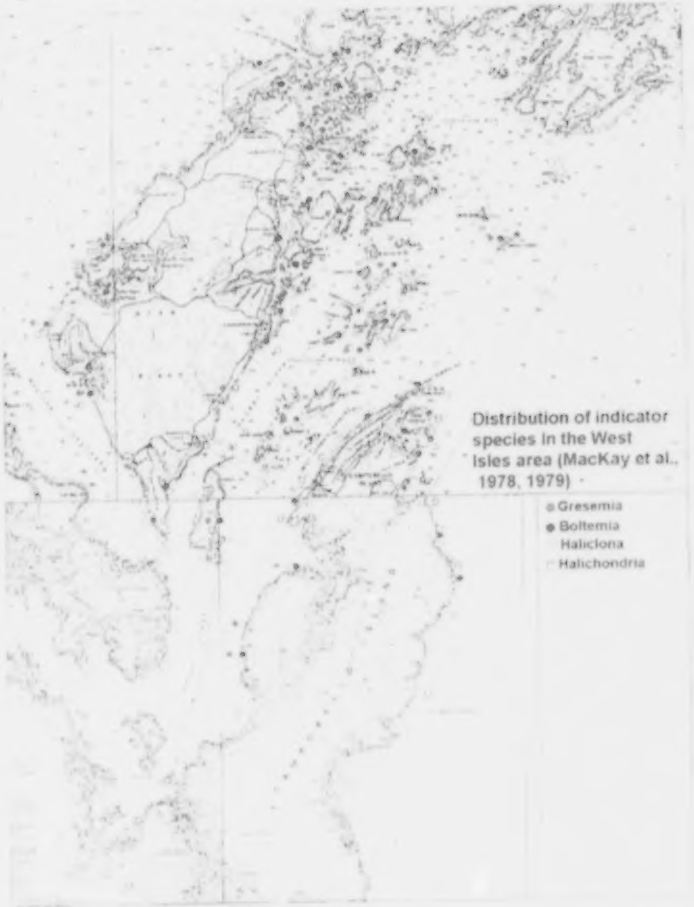

Distribution of indicator species in the West Isles area (MacKay et al., 1978, 1979)
Gresemia
Boltemia
Haliclona
Halichondria

Fig. D.2.24. Shoreline classification of the Wolves (CCRM, 1999).

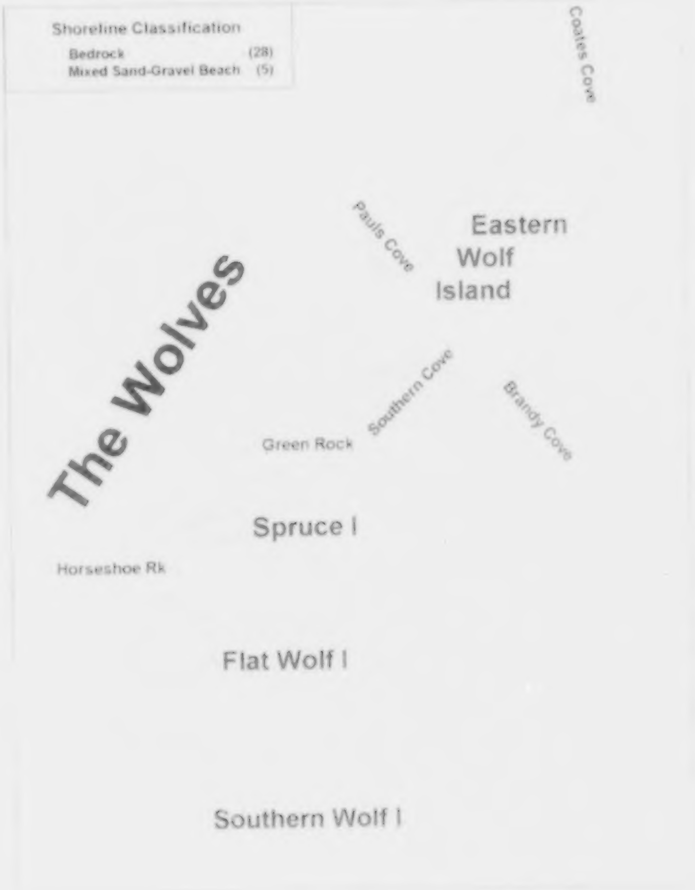

Shoreline Classification
Bedrock (28)
Mixed Sand-Gravel Beach (5)
Coates Cove
Pauls Cove
Eastern Wolf Island
The Wolves
Southern Cove
Brandy Cove
Green Rock
Spruce I
Horseshoe Rk
Flat Wolf I
Southern Wolf I

Figure D 2.25. Location of fishing weirs and kelp distribution.

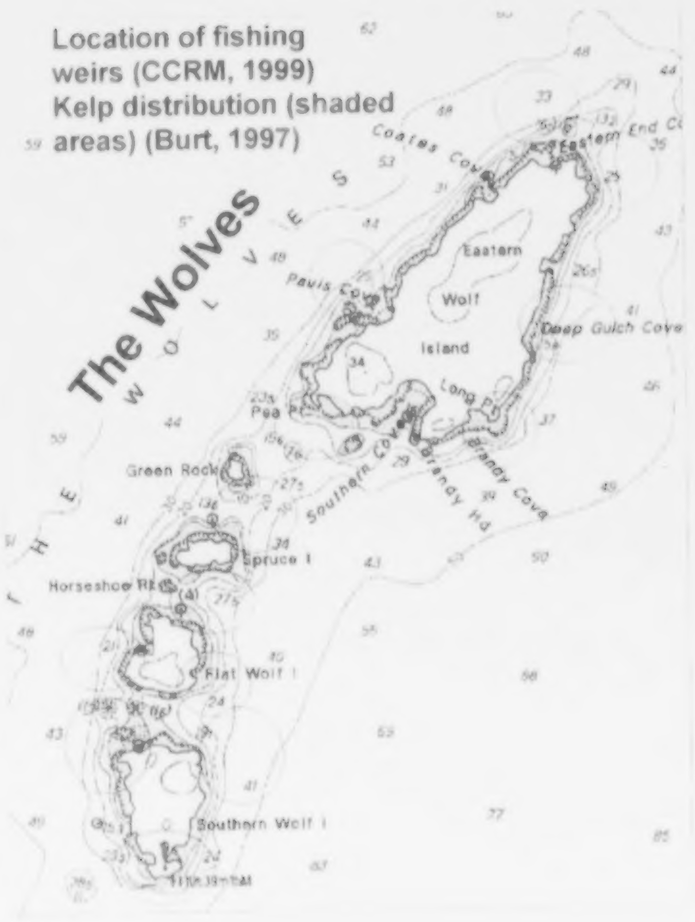

Location of fishing weirs (CCRM, 1999)
Kelp distribution (shaded areas) (Burt, 1997)
The Wolves
THE WOLVES
Coates Cove
Eastern End Cove
Pauls Cove
Eastern Wolf Island
Deep Gulch Cove
Long Pt
Pea Pt
Green Rock
Southern Cove
Brandy Hd
Brandy Cove
Spruce I
Horseshoe Rk
Flat Wolf I
Southern Wolf I

Figure D 2.26. Number of flora and fauna and areas of high diversity/abundance rating.

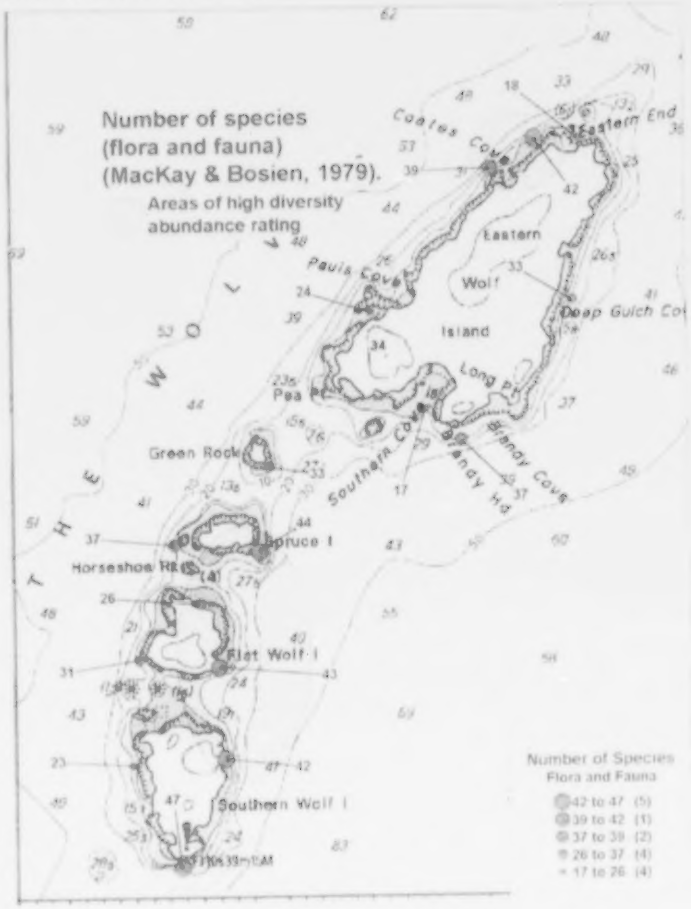

Number of species (flora and fauna) (MacKay & Bosien, 1979).
Areas of high diversity abundance rating
THE WOLVES
Coates Cove
Eastern End
Pauls Cove
Eastern Wolf Island
Deep Gulch Cove
Long Pt
Pea Pt
Green Rock
Southern Cove
Brandy Hd
Brandy Cove
Spruce I
Horseshoe Rk
Flat Wolf I
Southern Wolf I
Number of Species Flora and Fauna
42 to 47 (5)
39 to 42 (1)
37 to 39 (2)
26 to 37 (4)
17 to 26 (4)

Fig. D.2.27. Scallop beds and periwinkle harvesting areas.

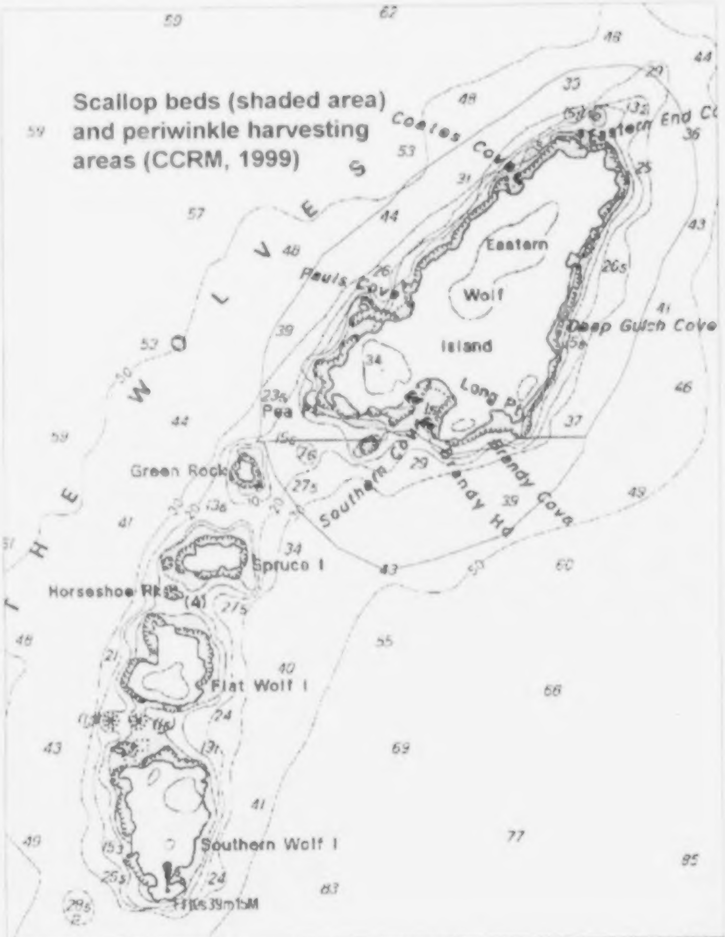

Scallop beds (shaded area)
and periwinkle harvesting
areas (CCRM, 1999)
THE WOLVES
Coates Cove
Eastern End Co
Eastern
Wolf
Island
Pauls Cove
Deep Gulch Cove
Long Pt
Pea Pt
Southern Cove
Brandy Hd
Brandy Cove
Green Rock
Spruce I
Horseshoe Rks
Flat Wolf I
Southern Wolf I

Fig. D.2.28. Names and locations in the Letang area.

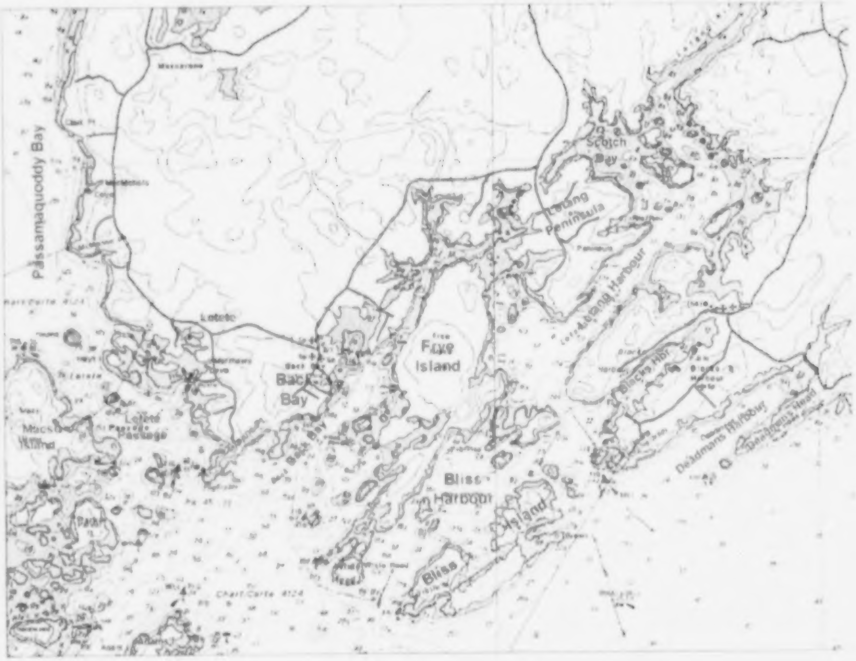

Passamaquoddy Bay
Letete
Letete Passage
Back Bay
Frye Island
Bliss Harbour
Bliss Island
Letang Peninsula
Letang Harbour
Scotch Bay
Blacks Hbr
Deadmans Harbour
Chart/Carte 4124

Fig. D.2.29. Shoreline Classification Back Bay to Letang (CCRM, 1999)

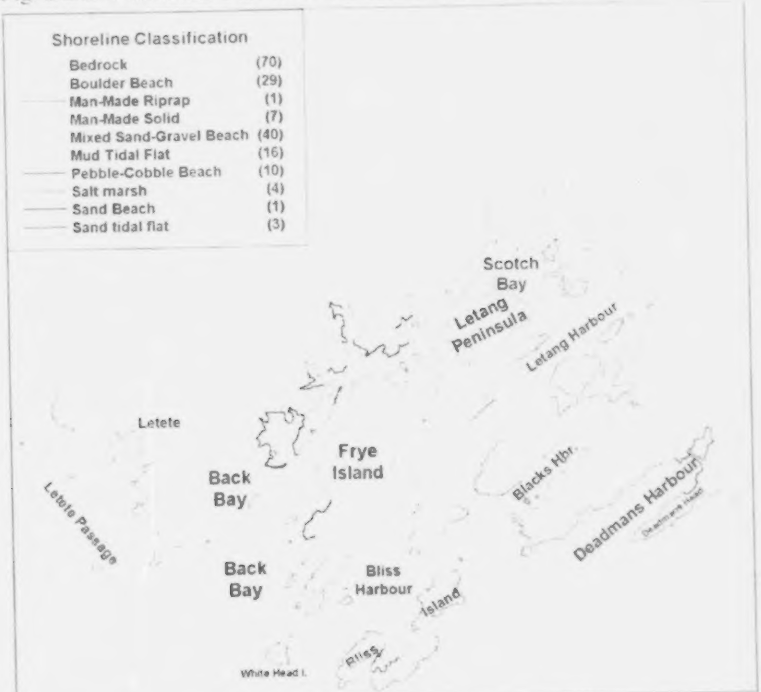

Shoreline Classification
Bedrock (70)
Boulder Beach (29)
Man-Made Riprap (1)
Man-Made Solid (7)
Mixed Sand-Gravel Beach (40)
Mud Tidal Flat (16)
Pebble-Cobble Beach (10)
Salt marsh (4)
Sand Beach (1)
Sand tidal flat (3)
Scotch Bay
Letang Peninsula
Letang Harbour
Letete
Frye Island
Back Bay
Letete Passage
Blacks Hbr.
Deadmans Harbour
Deadmans Head
Back Bay
Bliss Harbour
Island
Bliss
White Head I.

Fig. D.2.30. Relative lobster abundance determined by transects and Collection dives. Scallop and Soft shelled clam beds.

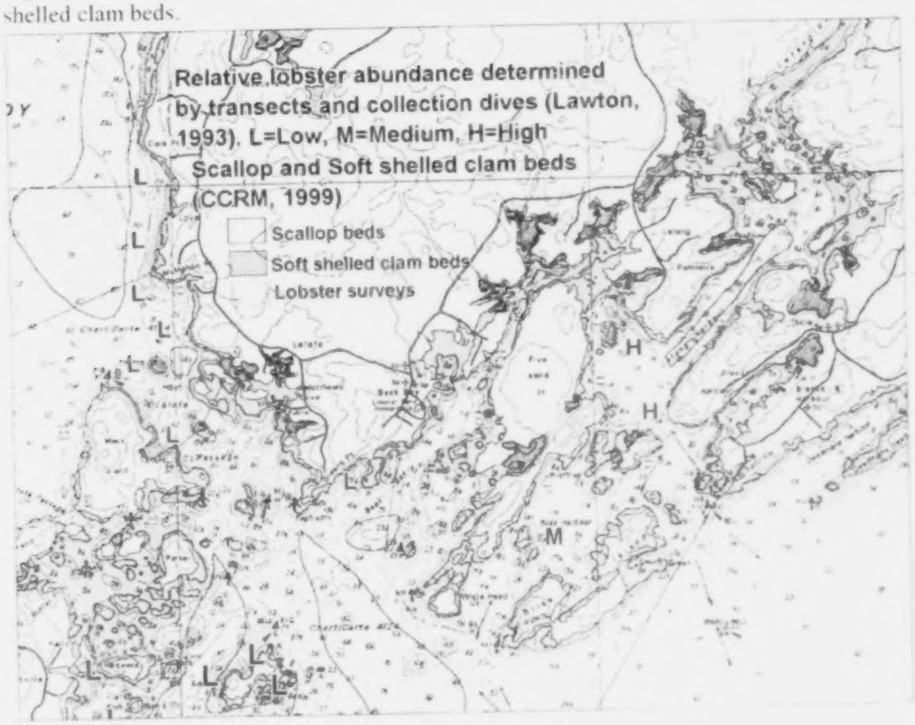

Relative lobster abundance determined by transects and collection dives (Lawton, 1993). L=Low, M=Medium, H=High
Scallop and Soft shelled clam beds (CCRM, 1999)
Scallop beds
Soft shelled clam beds
Lobster surveys
L
L
L
L
L
L
L
H
H
M
L
L
L
L

Figure D.2.31. Sea urchin and periwinkle harvesting areas. Sea cucumber 2000 fishing effort.

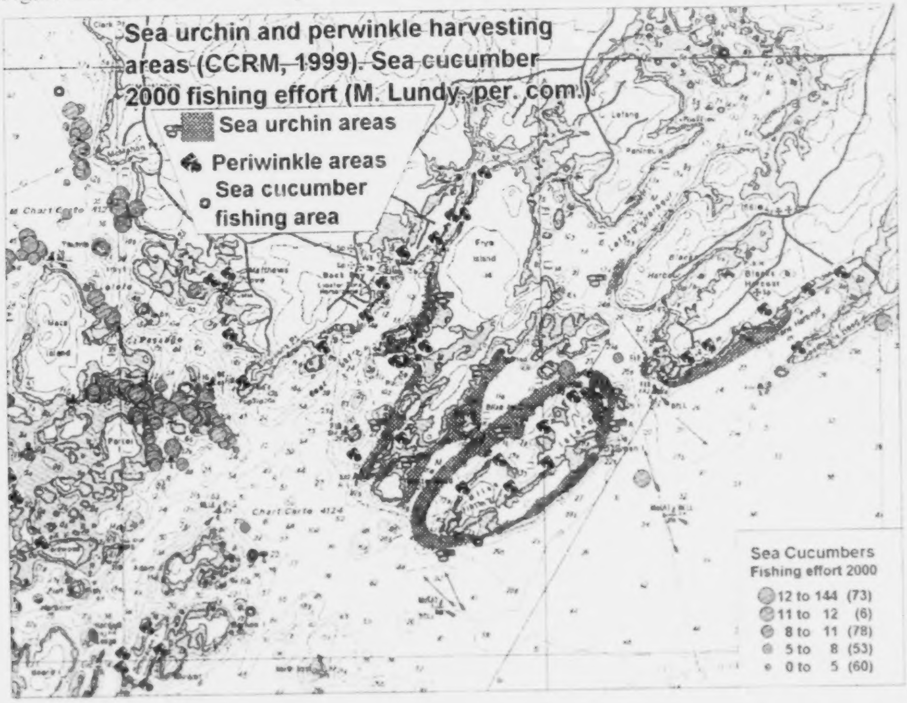

Sea urchin and perwinkle harvesting areas (CCRM, 1999). Sea cucumber 2000 fishing effort (M. Lundy, per. com.)
Sea urchin areas
Periwinkle areas
Sea cucumber fishing area
Frye Island
Chart/Carte 4124
Sea Cucumbers
Fishing effort 2000
12 to 144 (73)
11 to 12 (6)
8 to 11 (78)
5 to 8 (53)
0 to 5 (60)

Figure D.2.32. Locations of known seal haulouts from 1986 aerial surveys, dulse harvesting areas, and kelp distribution.

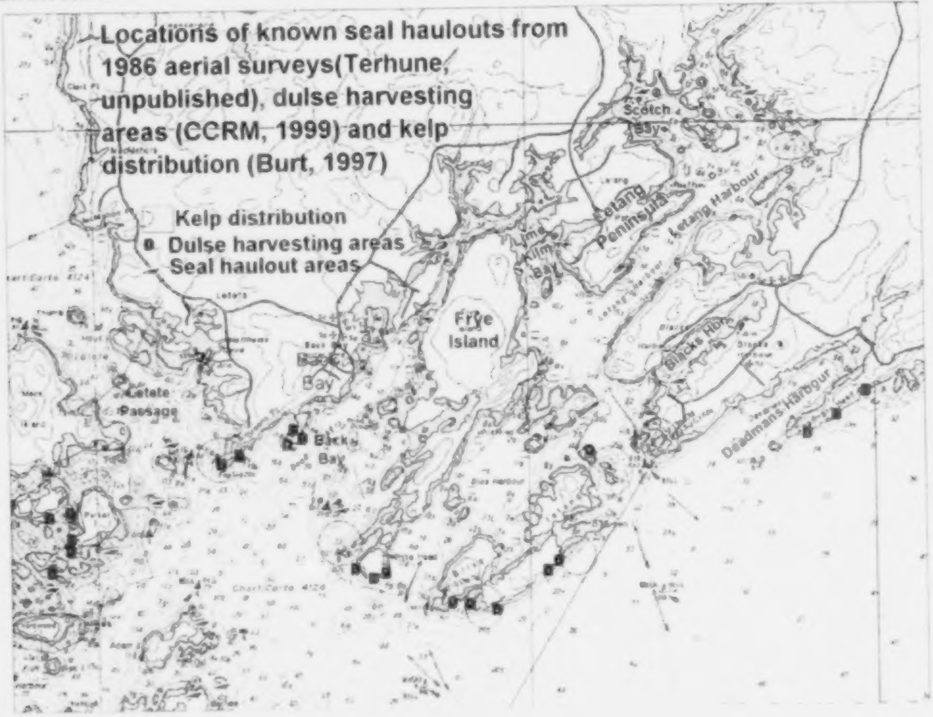

Locations of known seal haulouts from 1986 aerial surveys(Terhune, unpublished), dulse harvesting areas (CCRM, 1999) and kelp distribution (Burt, 1997)
Kelp distribution
Dulse harvesting areas
Seal haulout areas
Scotch Bay
Letang Peninsula
Letang Harbour
Limekiln Bay
Frye Island
Back Bay
Blacks Harbour
Deadmans Harbour
Letete Passage
Chart/Carte 4124

Fig. D.2.33. Number of species recorded by MacKay et al. (1878) during spot examinations.

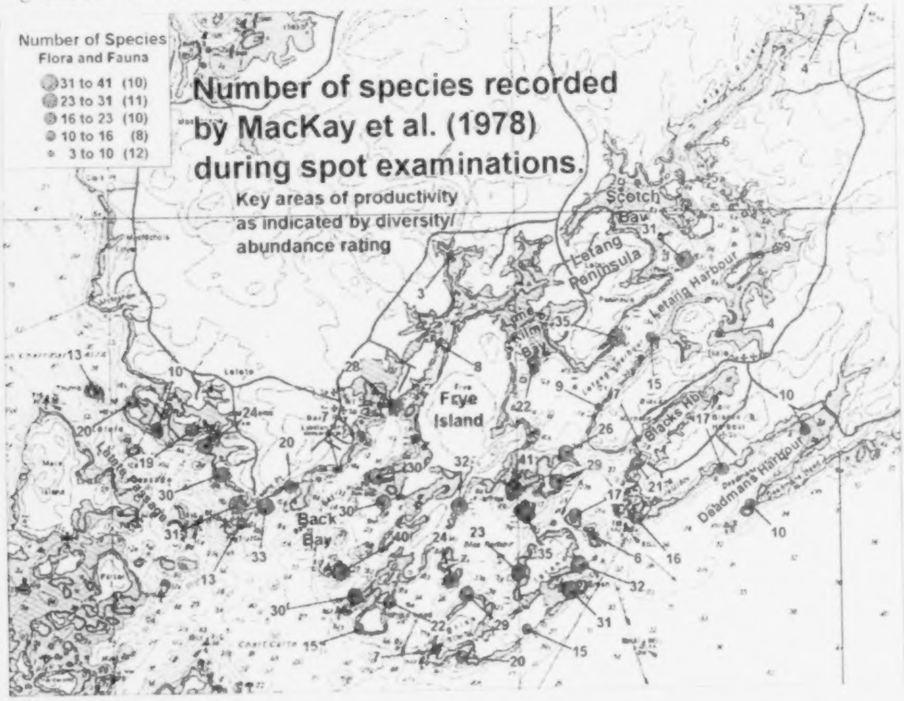

Number of Species
Flora and Fauna
31 to 41 (10)
23 to 31 (11)
16 to 23 (10)
10 to 16 (8)
3 to 10 (12)
Number of species recorded by MacKay et al. (1978) during spot examinations.
Key areas of productivity as indicated by diversity/ abundance rating
Scotch Bay
Letang Peninsula
Letang Harbour
Long Fillmore Bay
Frye Island
Back Bay
Blacks Harbour
Deadmans Harbour

Figure D.2.34. Location of aquaculture sites and herring weirs.

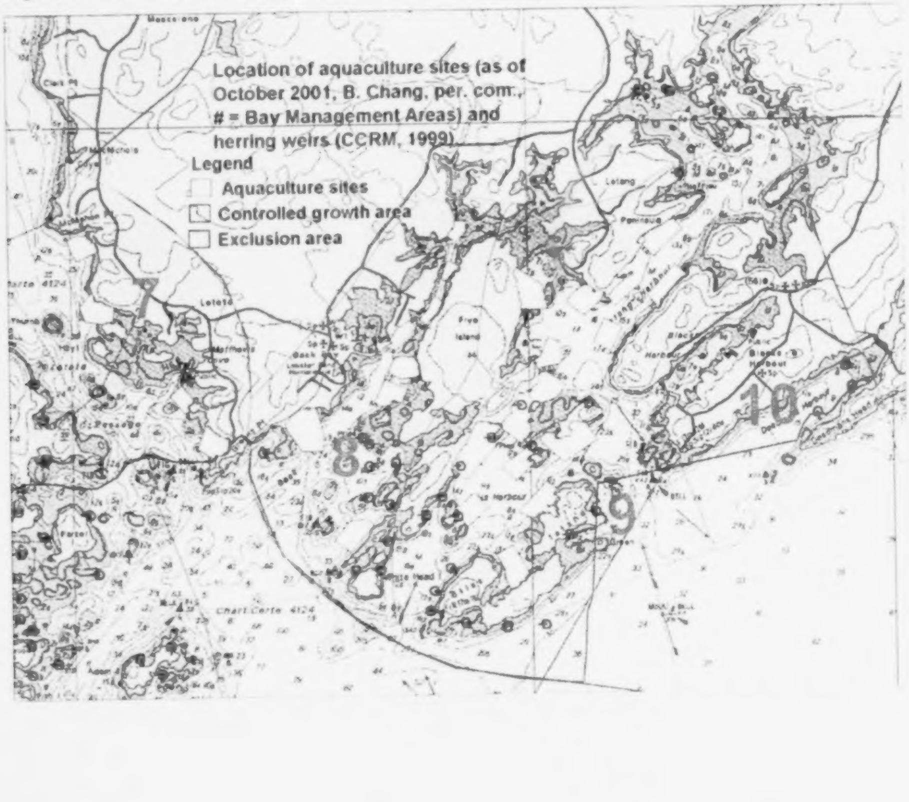

Location of aquaculture sites (as of October 2001, B. Chang, per. com., # = Bay Management Areas) and herring weirs (CCRM, 1999)
Legend
Aquaculture sites
Controlled growth area
Exclusion area
7
8
9
10
Letang
Frye Island
Chart/Carte 4124

Fig. D.2.35. Shoreline Classification Maces Bay (CCRM, 1999).

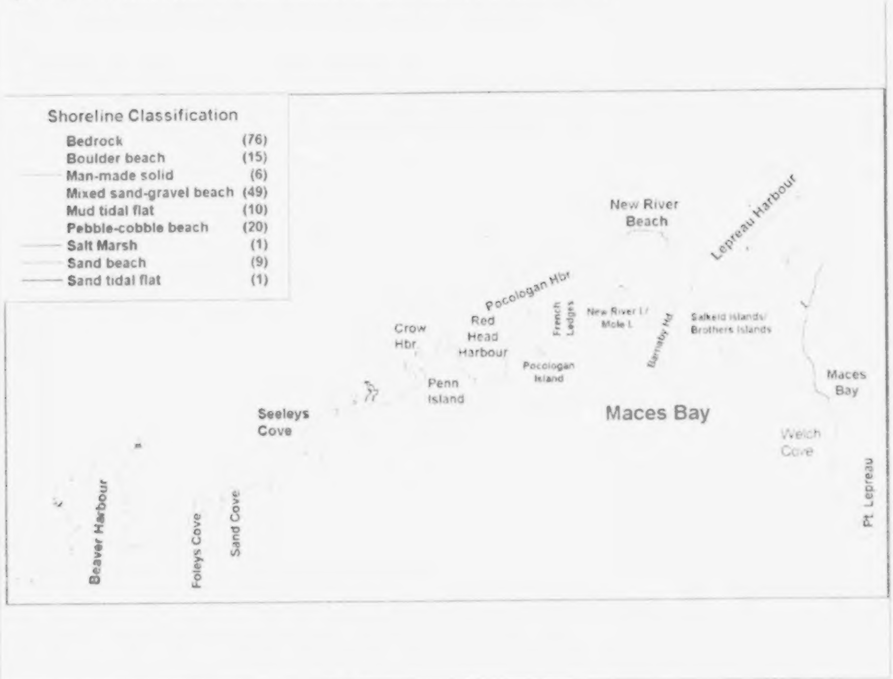

Shoreline Classification
Bedrock (76)
Boulder beach (15)
Man-made solid (6)
Mixed sand-gravel beach (49)
Mud tidal flat (10)
Pebble-cobble beach (20)
Salt Marsh (1)
Sand beach (9)
Sand tidal flat (1)
New River Beach
Lepreau Harbour
Pocologan Hbr
French Ledges
New River I./ Mole I.
Barnaby Hd
Salkeld Islands/ Brothers Islands
Crow Hbr
Red Head Harbour
Pocologan Island
Penn Island
Maces Bay
Seeleys Cove
Maces Bay
Welch Cove
Beaver Harbour
Foleys Cove
Sand Cove
Pt. Lepreau

Fig. D.2.36. Locations of known seal haulouts from 1986 aerial surveys. Relative lobster abundance determined by transects and collection dives.

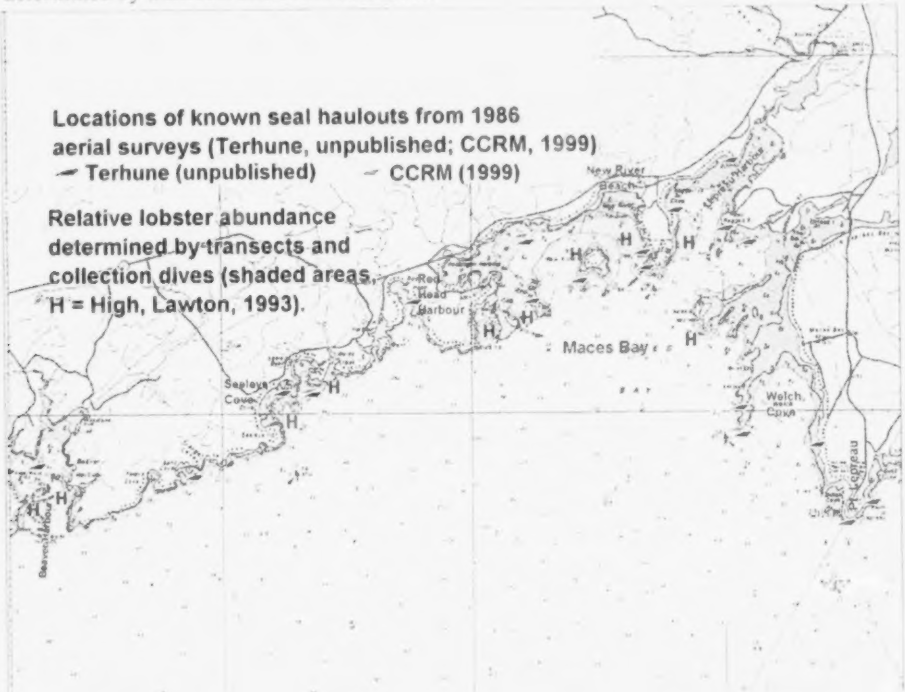

Locations of known seal haulouts from 1986 aerial surveys (Terhune, unpublished; CCRM, 1999)
Terhune (unpublished)
CCRM (1999)
Relative lobster abundance determined by transects and collection dives (shaded areas, H = High, Lawton, 1993).
New River Beach
Lepreau Harbour
Red Head Harbour
Maces Bay
Seeleys Cove
Welch Cove
Pt. Lepreau
Beaver Harbour
H

Fig. D.2.37. Number of species recorded by MacKay et al. (1978) in Maces Bay.

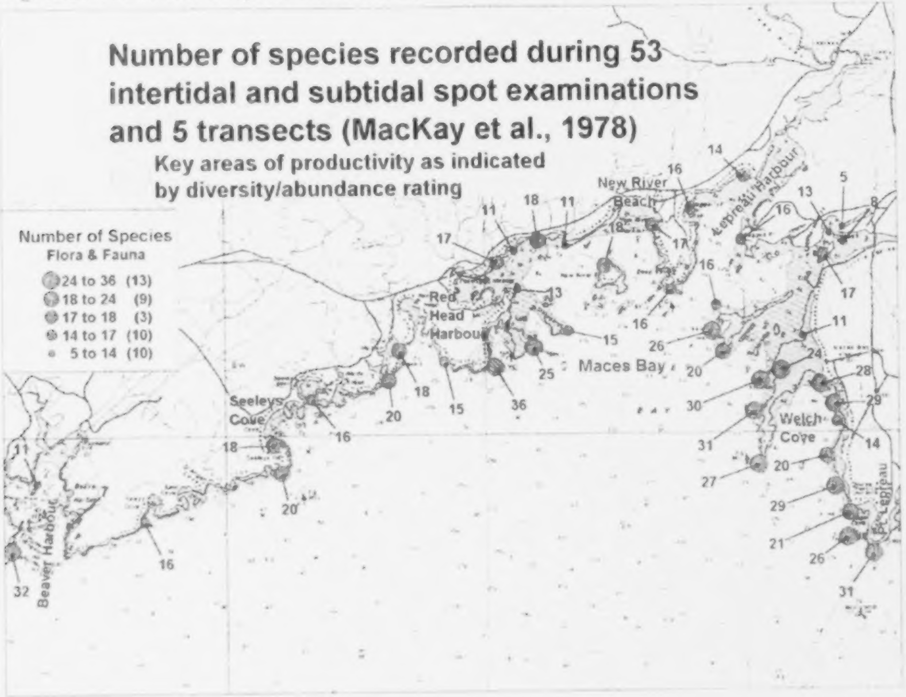

Number of species recorded during 53 intertidal and subtidal spot examinations and 5 transects (MacKay et al., 1978)
Key areas of productivity as indicated by diversity/abundance rating
Number of Species Flora & Fauna
24 to 36 (13)
18 to 24 (9)
17 to 18 (3)
14 to 17 (10)
5 to 14 (10)
New River Beach
Lepreau Harbour
Red Head Harbour
Maces Bay
Seeleys Cove
Welch Cove
Beaver Harbour
Pt. Lepreau

Fig. D.2.38. Dulse harvesting areas, exposed and sheltered seaweed research sites and *Ascophyllum* study site.

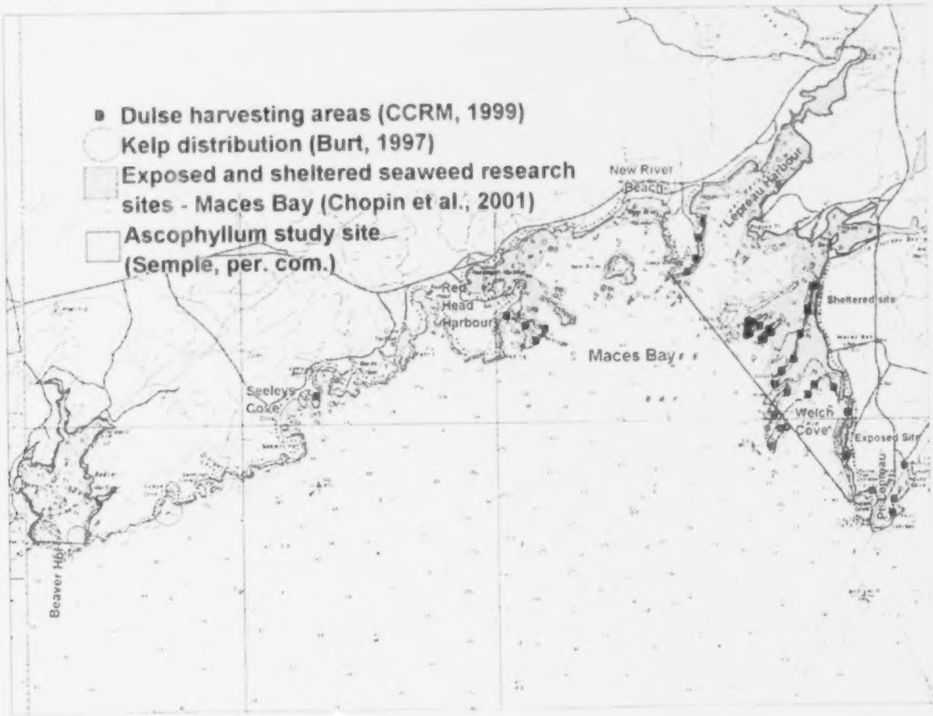

Dulse harvesting areas (CCRM, 1999)
Kelp distribution (Burt, 1997)
Exposed and sheltered seaweed research sites - Maces Bay (Chopin et al., 2001)
Ascophyllum study site (Semple, per. com.)
New River Beach
Lepreau Harbour
Red Head Harbour
Maces Bay
Seeleys Cove
Sheltered site
Welch Cove
Exposed Site
Pt. Lepreau
Beaver Hbr.

Fig. D.2.39. Scallop and soft shelled clam beds, and periwinkle and sea urchin harvesting areas.

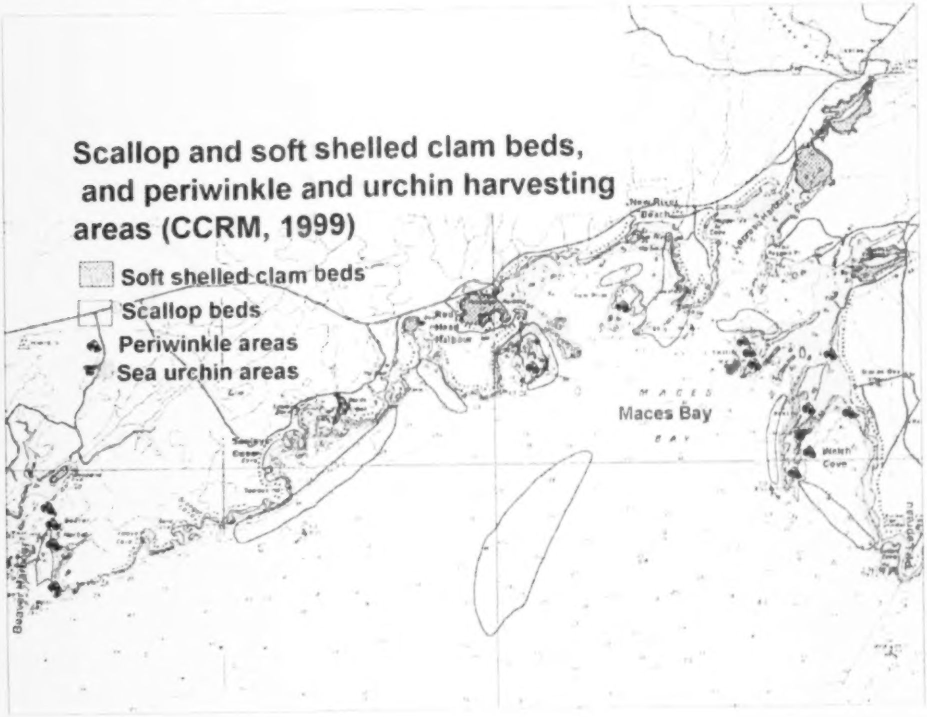

Scallop and soft shelled clam beds, and periwinkle and urchin harvesting areas (CCRM, 1999)
Soft shelled clam beds
Scallop beds
Periwinkle areas
Sea urchin areas
New River Beach
Red Head Harbour
Seeleys Cove
Maces Bay
Welch Cove
Beaver Harbour

Fig. D.2.40. Location of aquaculture sites and herring weirs.

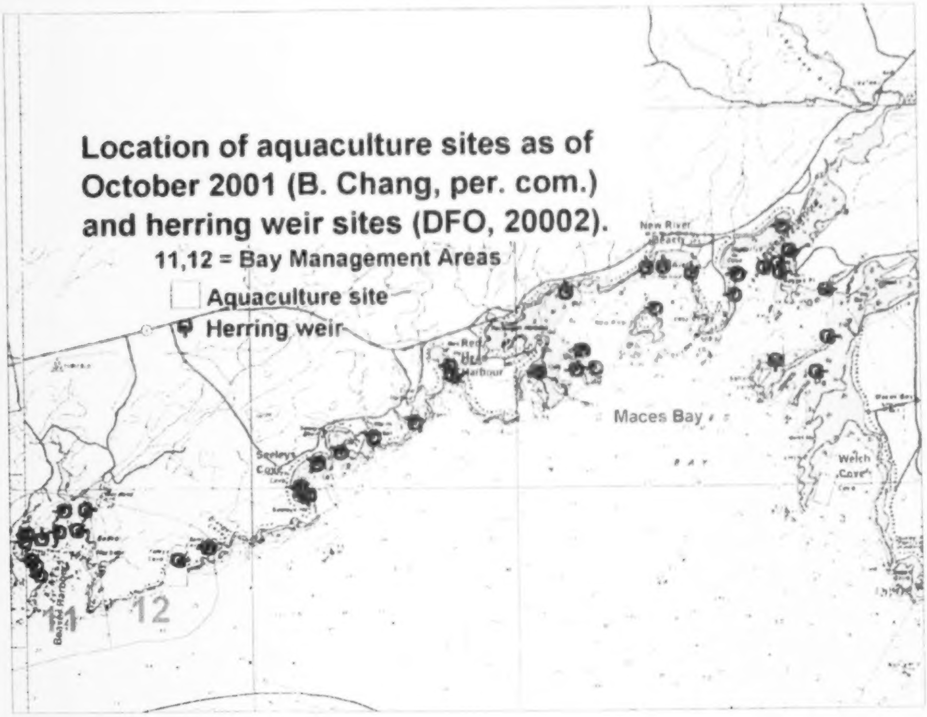

Location of aquaculture sites as of October 2001 (B. Chang, per. com.) and herring weir sites (DFO, 20002).
11,12 = Bay Management Areas
Aquaculture site
Herring weir
New River Beach
Red Head Harbour
Seeleys Cove
Maces Bay
Welch Cove
Beaver Harbour
11
12

Fig. D.2.41. Distribution of *Chlorophycophyta*.

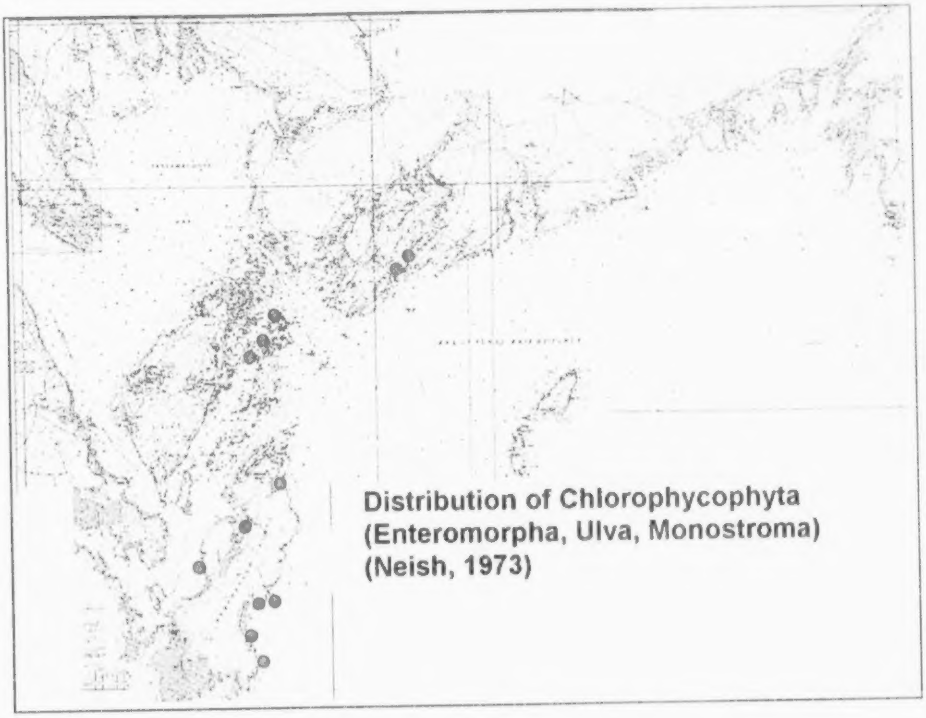

Distribution of Chlorophycophyta
(Enteromorpha, Ulva, Monostroma)
(Neish, 1973)

Fig. D.2.42. Distribution of *Laminariales*.

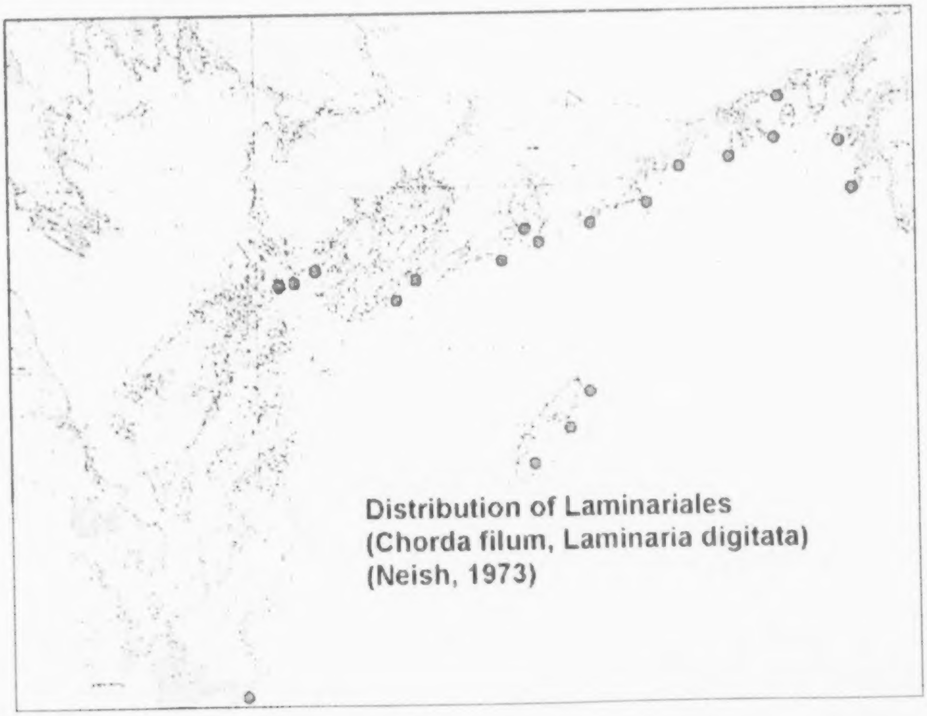

Distribution of Laminariales
(Chorda filum, Laminaria digitata)
(Neish, 1973)

Fig. D.2.43. Distribution of wide-frond *Laminaria longicruris*.

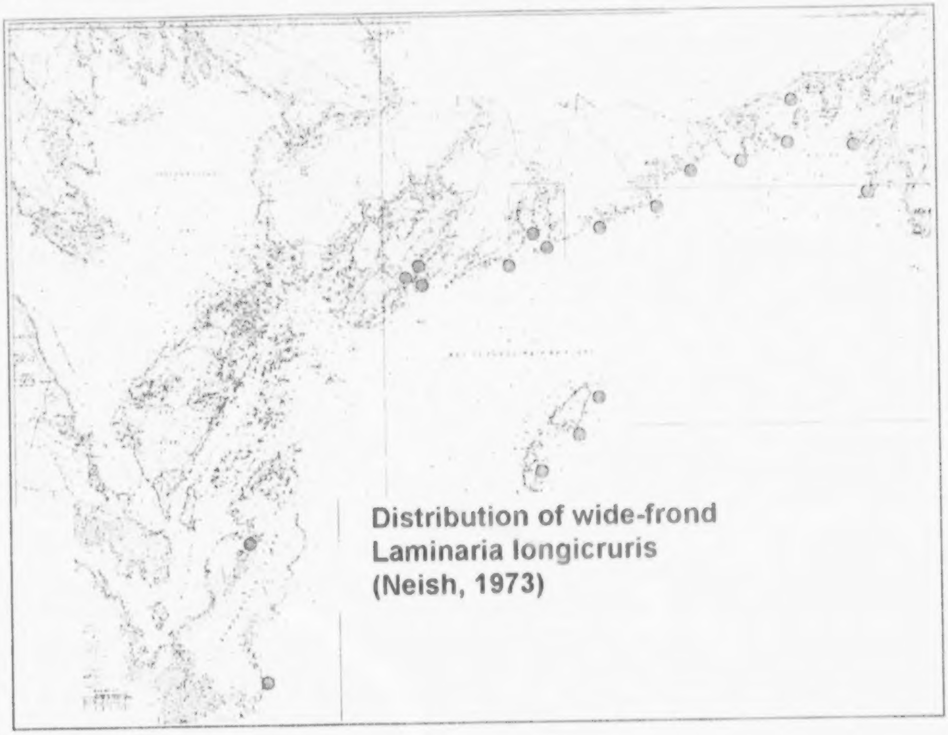

Distribution of wide-frond
Laminaria longicruris
(Neish, 1973)

Fig. D.2.44. Distribution of *Porphyra*.

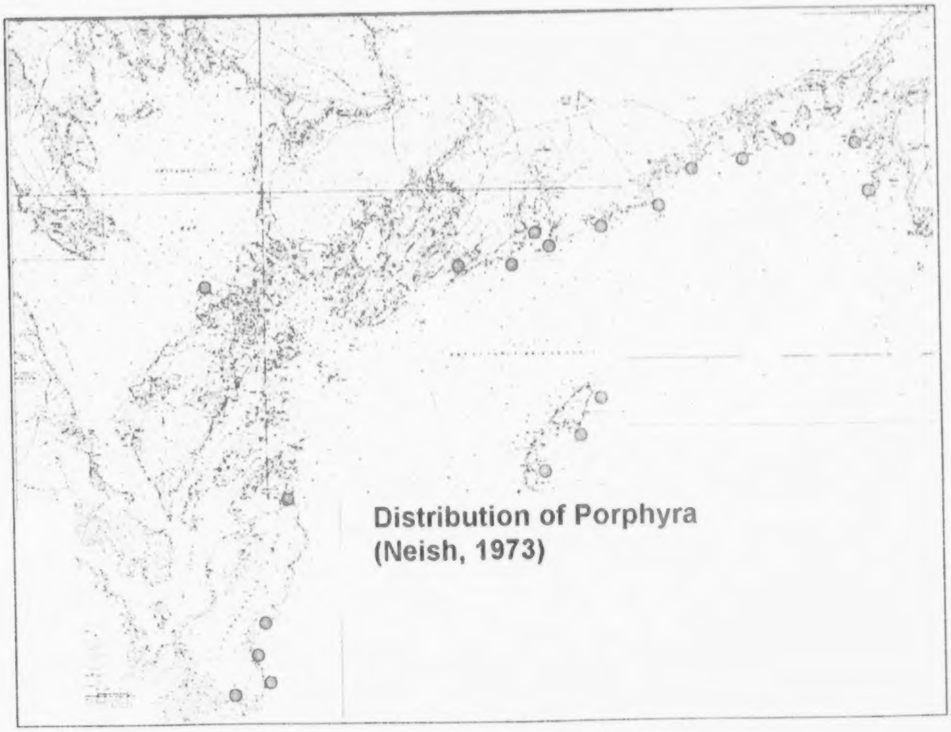

Distribution of Porphyra
(Neish, 1973)

Fig. D.3.1. Shoreline classification for Point Lepreau to Saint John Harbour (CCRM, 1999).

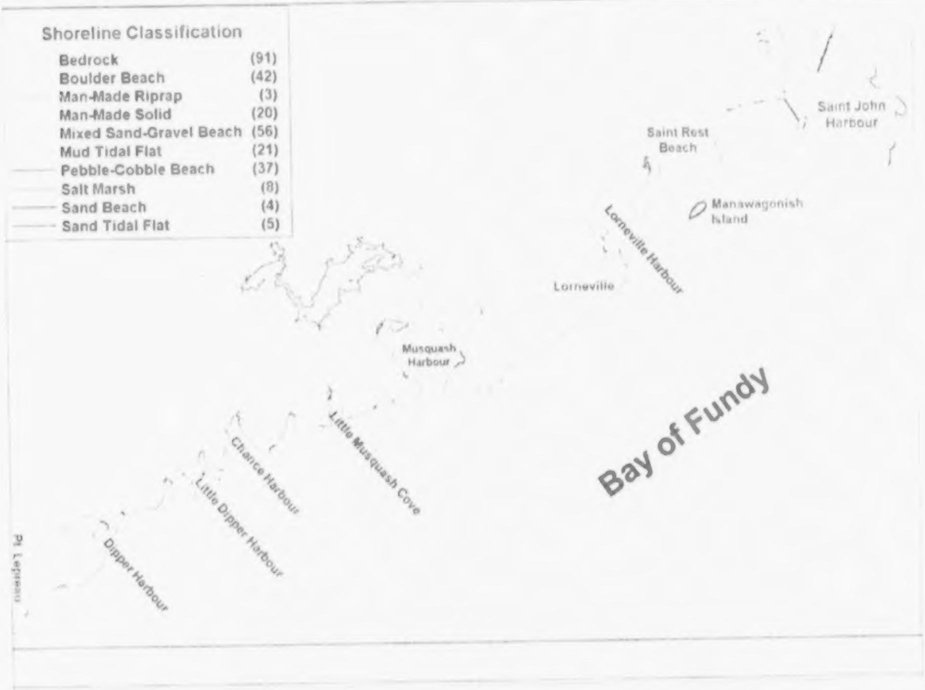

Shoreline Classification
Bedrock (91)
Boulder Beach (42)
Man-Made Riprap (3)
Man-Made Solid (20)
Mixed Sand-Gravel Beach (56)
Mud Tidal Flat (21)
Pebble-Cobble Beach (37)
Salt Marsh (8)
Sand Beach (4)
Sand Tidal Flat (5)
Saint John Harbour
Saint Rest Beach
Manawagonish Island
Lorneville Harbour
Lorneville
Musquash Harbour
Bay of Fundy
Little Musquash Cove
Chance Harbour
Little Dipper Harbour
Dipper Harbour
Pt Lepreau

Fig. D.3.2. Location of salt marshes, and known seal haulouts.

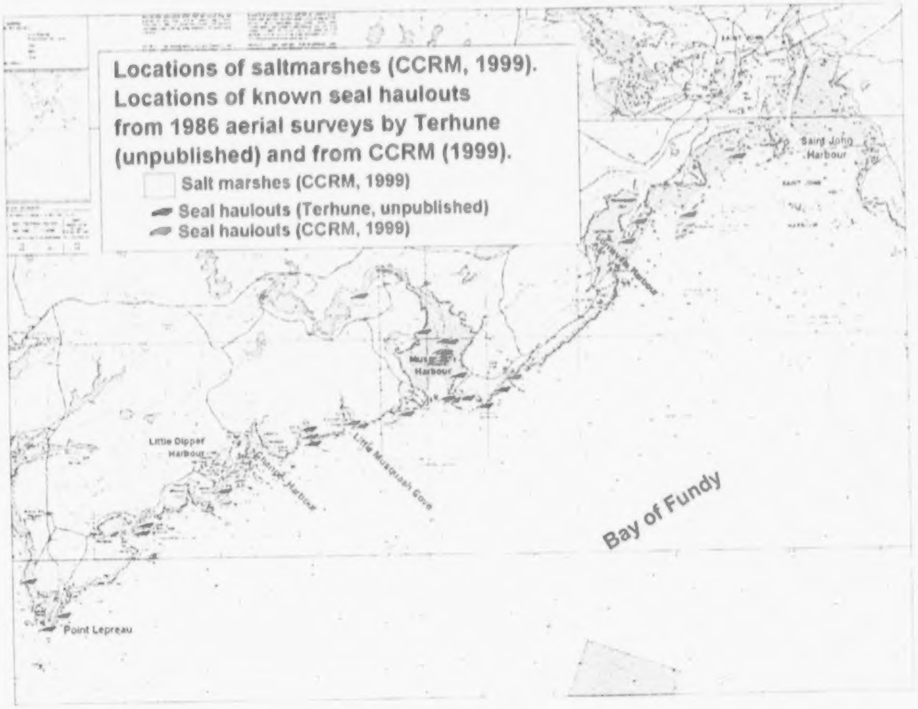

Locations of saltmarshes (CCRM, 1999).
Locations of known seal haulouts
from 1986 aerial surveys by Terhune
(unpublished) and from CCRM (1999).
Salt marshes (CCRM, 1999)
Seal haulouts (Terhune, unpublished)
Seal haulouts (CCRM, 1999)
Saint John Harbour
Musquash Harbour
Little Dipper Harbour
Chance Harbour
Little Musquash Cove
Bay of Fundy
Point Lepreau

Fig. D.3.3. Location of herring weirs (DFO, 2002), and scallop and soft shelled clam beds.

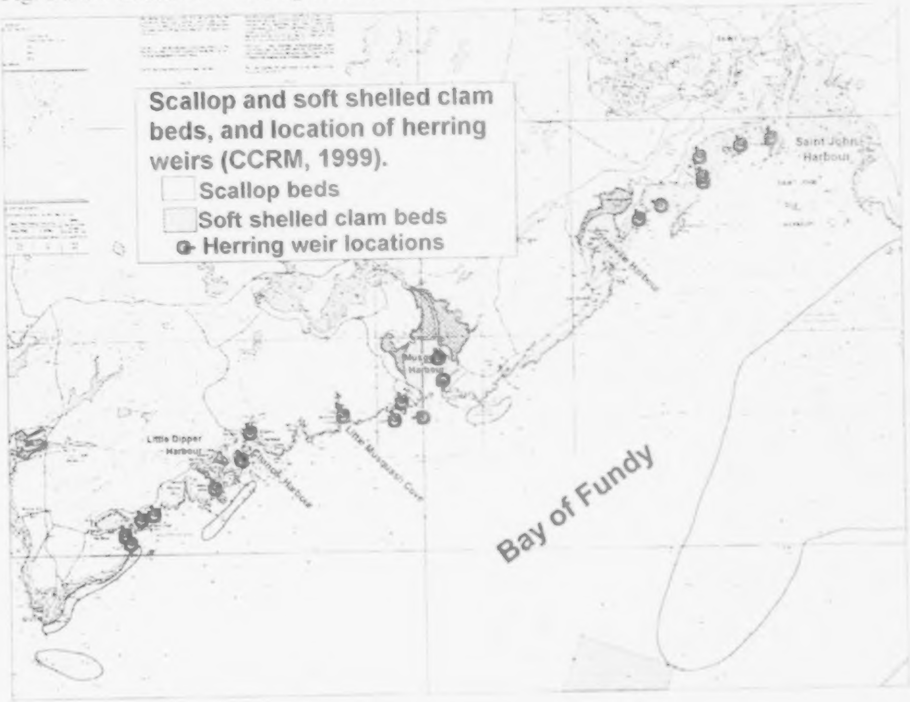

Scallop and soft shelled clam beds, and location of herring weirs (CCRM, 1999).
Scallop beds
Soft shelled clam beds
Herring weir locations
Saint John Harbour
Musquash Harbour
Little Dipper Harbour
Chance Harbour
Little Musquash Cove
Bay of Fundy

Fig. 3.4. Periwinkle and sea urchin harvesting areas. *Ascophyllum* study site.

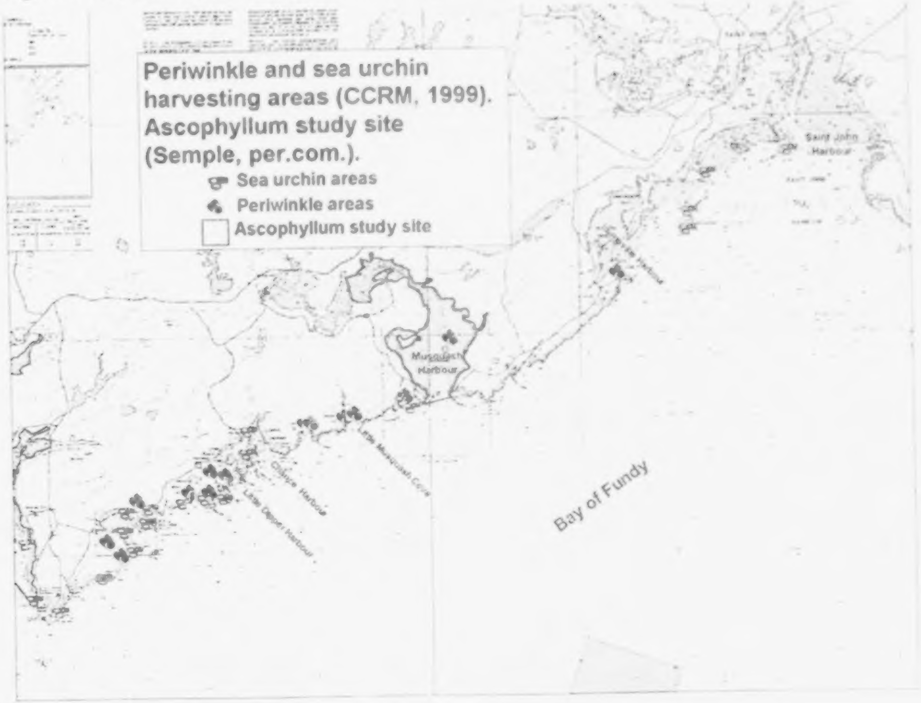

Periwinkle and sea urchin harvesting areas (CCRM, 1999).
Ascophyllum study site
(Semple, per.com.).
Sea urchin areas
Periwinkle areas
Ascophyllum study site
Saint John Harbour
Musquash Harbour
Little Musquash Cove
Chance Harbour
Little Dipper Harbour
Bay of Fundy

Fig. D.3.5. Number of species recorded by MacKay (1975).

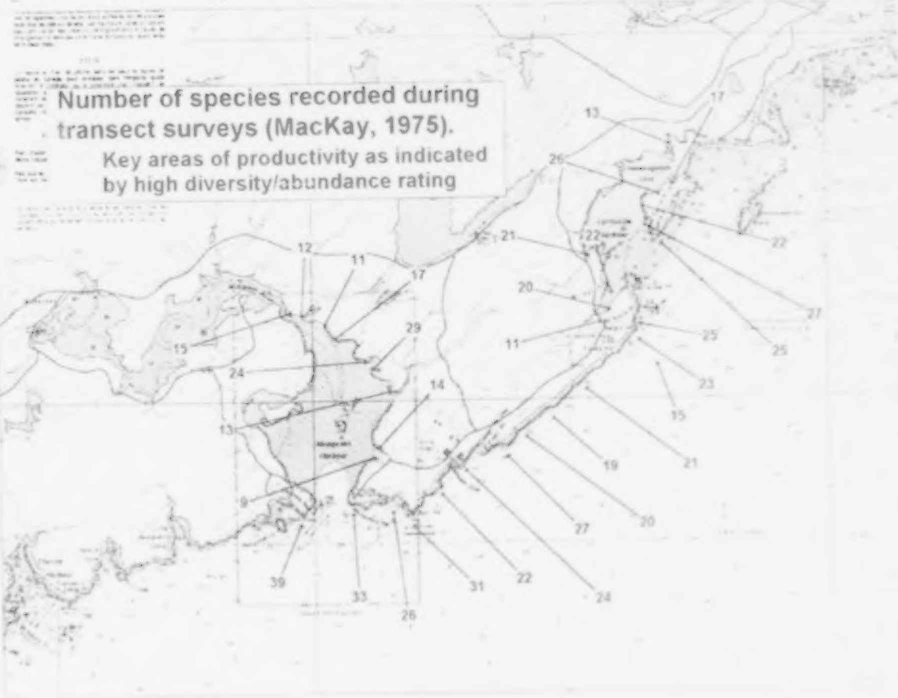

Number of species recorded during transect surveys (MacKay, 1975).
Key areas of productivity as indicated by high diversity/abundance rating
17
13
26
22
21
22
27
20
25
11
25
23
15
21
19
20
27
24
22
31
26
33
39
9
13
14
24
29
15
17
11
12

Fig. D.3.6. Proposed Musquash Marine Protected Area.

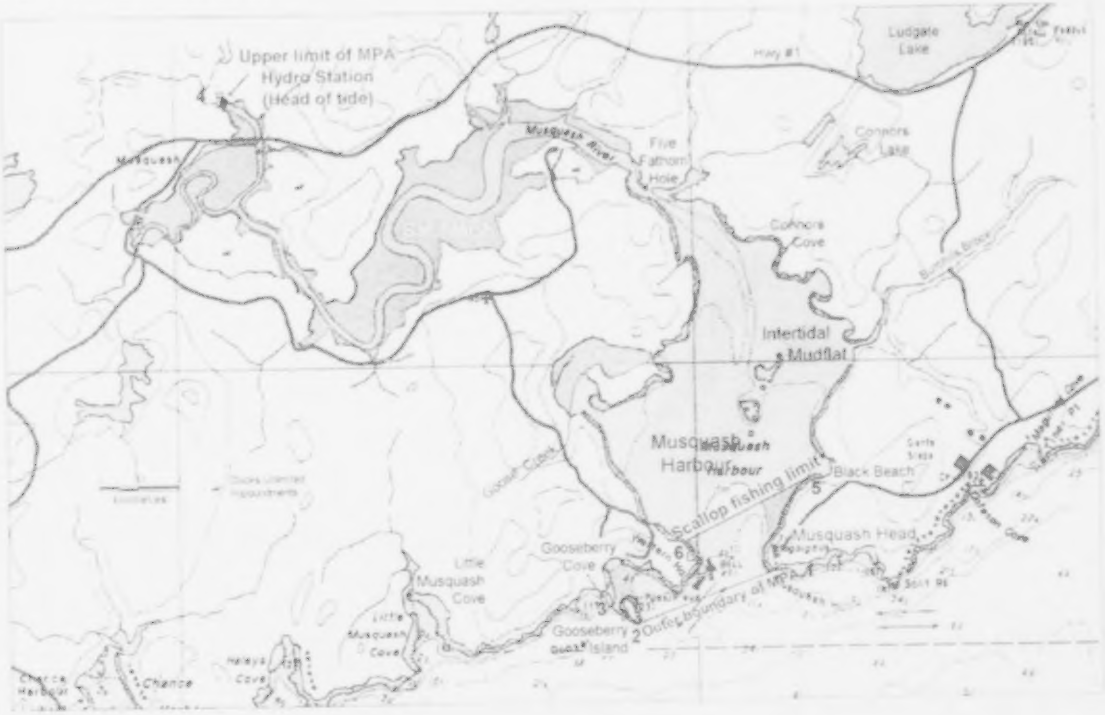

Upper limit of MPA
Hydro Station (Head of tide)
4
Musquash
Musquash River
Hwy #1
Ludgate Lake
Five Fathom Hole
Connors Lake
Connors Cove
Intertidal Mudflat
Musquash Harbour
Scallop fishing limit
Black Beach
5
Musquash Head
6
Gooseberry Cove
Little Musquash Cove
3
2
Gooseberry Island
Outer boundary of MPA
Little Musquash Cove
Haleys Cove
Chance Harbour
Chance
Goose Creek

Fig. D.3.7. Shoreline classification from Saint John Harbour to Alma (CCRM, 1999).

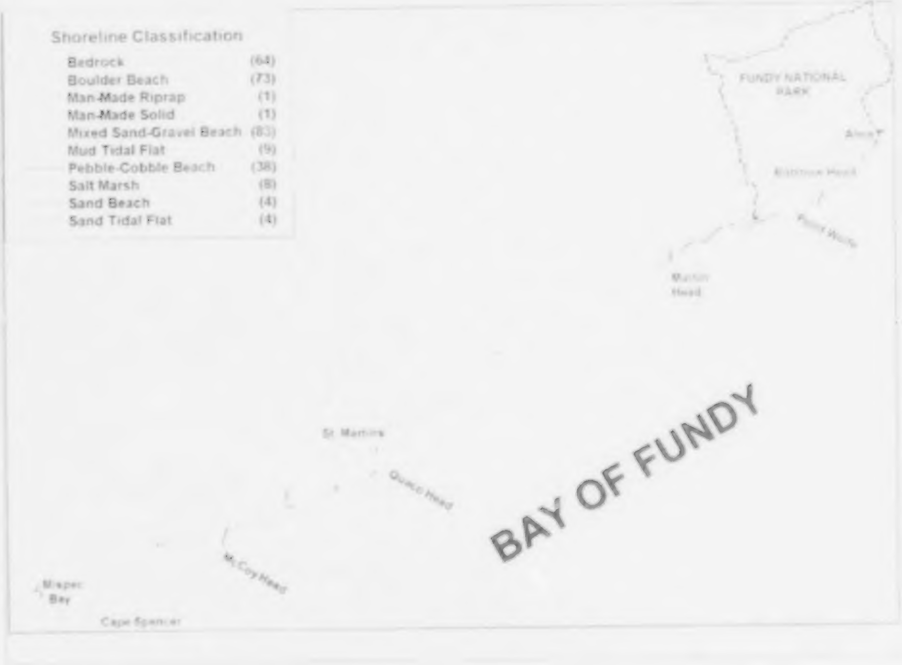

Shoreline Classification
Bedrock (64)
Boulder Beach (73)
Man-Made Riprap (1)
Man-Made Solid (1)
Mixed Sand-Gravel Beach (83)
Mud Tidal Flat (9)
Pebble-Cobble Beach (38)
Salt Marsh (8)
Sand Beach (4)
Sand Tidal Flat (4)
FUNDY NATIONAL PARK
Alma
Point Wolfe
Martin Head
St. Martins
Quaco Head
McCoy Head
Mispec Bay
Cape Spencer
BAY OF FUNDY

Fig. D.3.8. Location of salt marshes between Saint John and Alma.

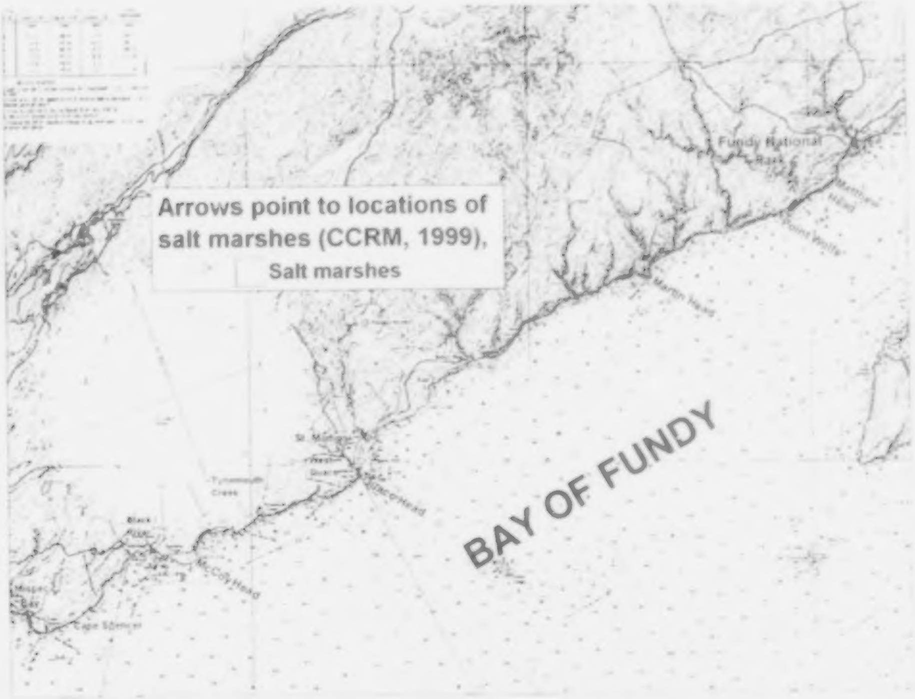

Arrows point to locations of salt marshes (CCRM, 1999),
Salt marshes
Fundy National Park
Point Wolfe
Martin Head
St. Martins
Quaco Head
McCoy Head
Mispec Bay
Cape Spencer
BAY OF FUNDY

Fig. D.3.9. Location of lobster spawning area, and scallop and soft shelled clam beds

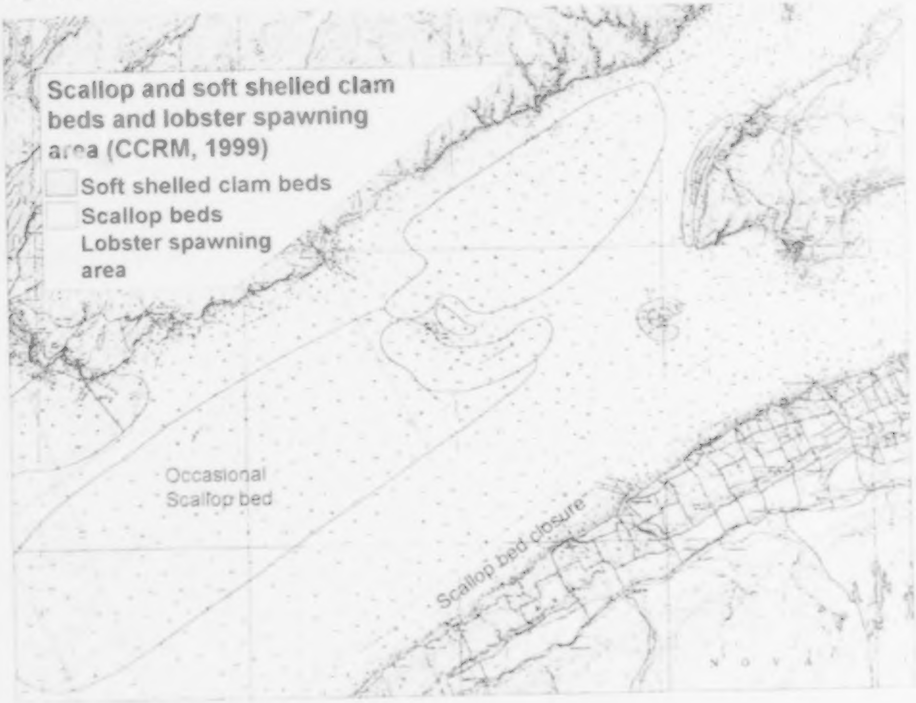

Scallop and soft shelled clam beds and lobster spawning area (CCRM, 1999)
Soft shelled clam beds
Scallop beds
Lobster spawning area
Occasional Scallop bed
Scallop bed closure
N O V A

Fig. D.3.10. Sea urchin and periwinkle distribution areas.

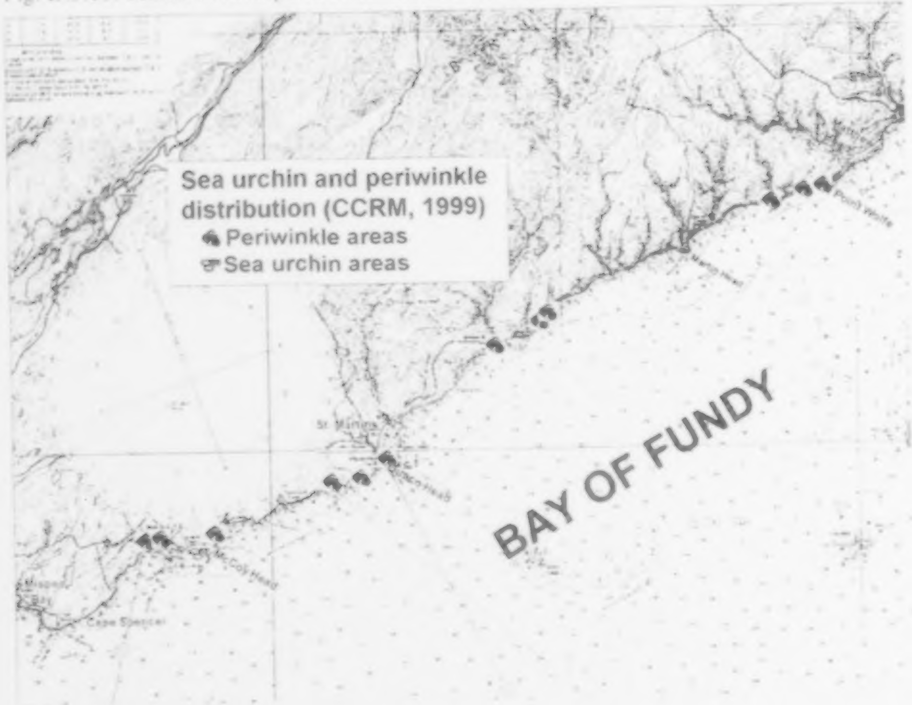

Sea urchin and periwinkle distribution (CCRM, 1999)
Periwinkle areas
Sea urchin areas
St. Martins
Cape Spencer
BAY OF FUNDY

Fig. D.4.1. Names of places in the Upper Bay of Fundy.

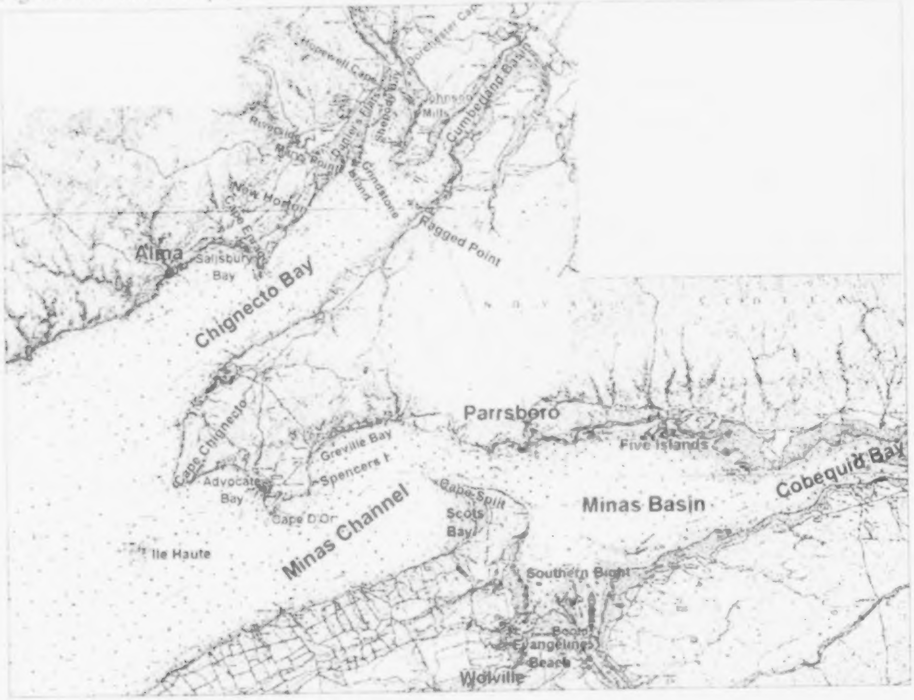

Hopewell Cape
Dorchester Cape
Shepody Bay
Johnson's Mills
Cumberland Basin
Riverside
Marys Point
Grindstone Island
New Horton
Cape Enrage
Alma
Salisbury Bay
Chignecto Bay
Ragged Point
N O V A   S C O T I A
Parrsboro
Five Islands
Cape Chignecto
Greville Bay
Spencers I.
Advocate Bay
Cape D'Or
Cape Split
Scots Bay
Minas Basin
Cobequid Bay
Ile Haute
Minas Channel
Southern Bight
Boot
Evangeline Beach
Wolfville

Fig. D.4.2. Shoreline classification - Upper Bay of Fundy (CCRM, 1999).

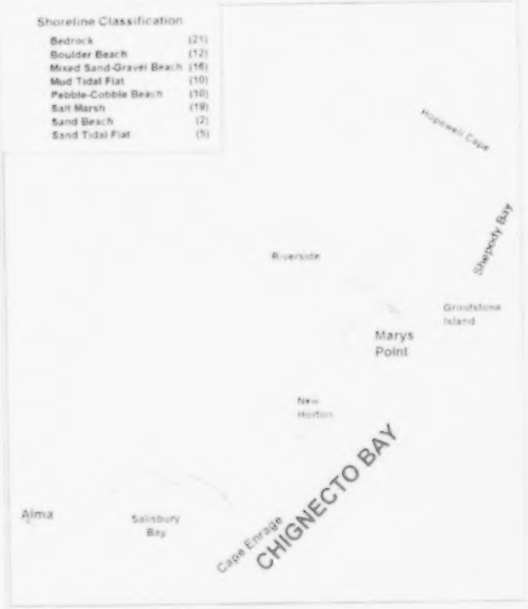

Shoreline Classification
Bedrock (21)
Boulder Beach (12)
Mixed Sand-Gravel Beach (16)
Mud Tidal Flat (10)
Pebble-Cobble Beach (10)
Salt Marsh (19)
Sand Beach (2)
Sand Tidal Flat (5)
Hopewell Cape
Shepody Bay
Riverside
Grindstone Island
Marys Point
New Horton
CHIGNECTO BAY
Alma
Salisbury Bay
Cape Enrage

Fig. D.4.3. Macrofauna in the Upper Bay of Fundy (DFO, 2002).

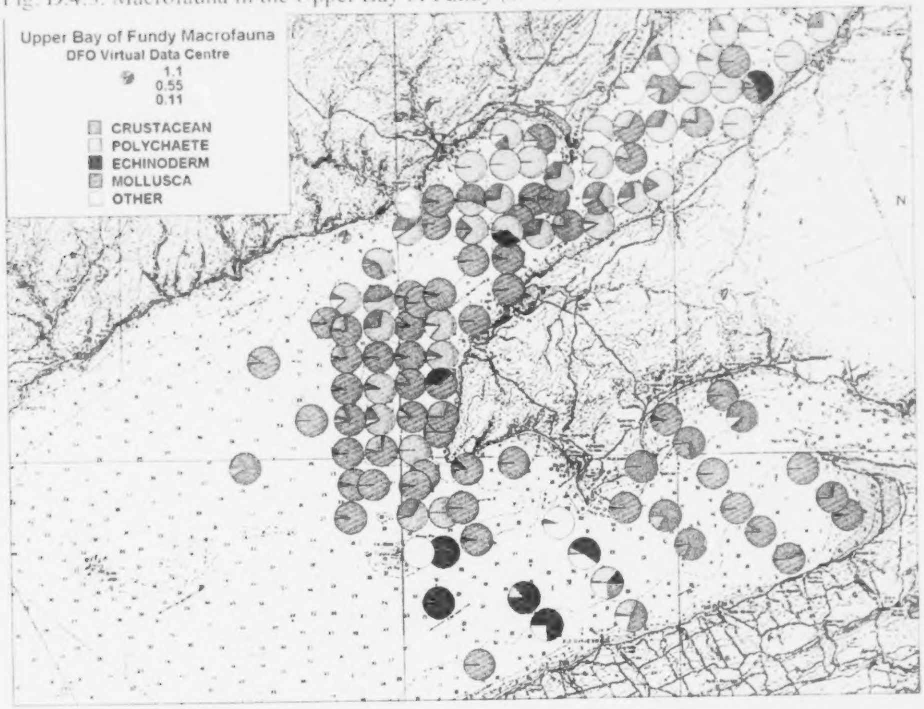

Upper Bay of Fundy Macrofauna
DFO Virtual Data Centre
1.1
0.55
0.11
CRUSTACEAN
POLYCHAETE
ECHINODERM
MOLLUSCA
OTHER
N

Fig. D.4.4. Scallop and soft shelled clam beds, urchin distribution and herring larvae concentration.

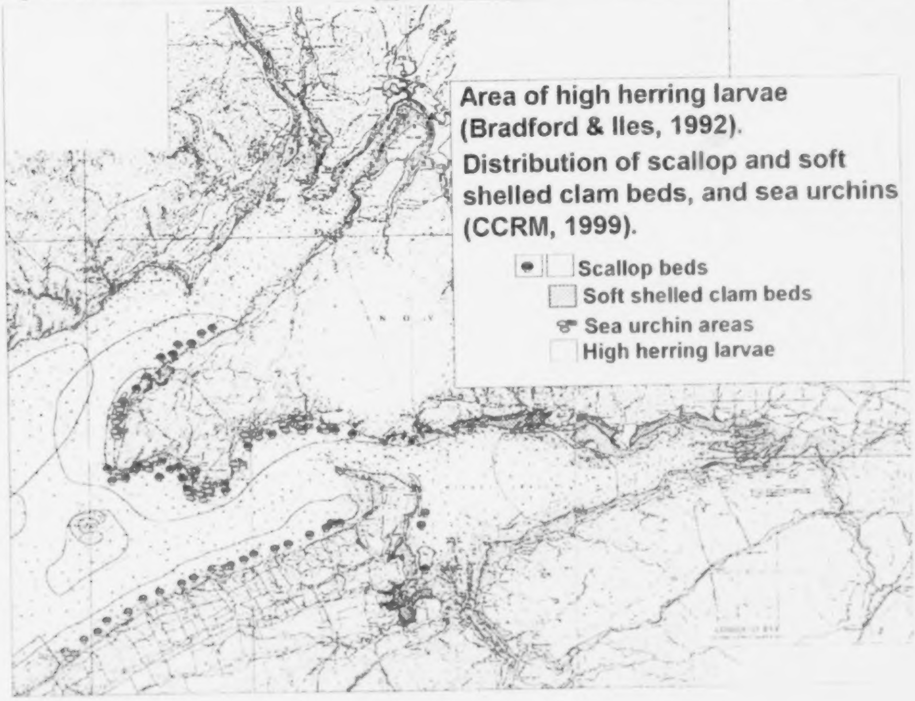
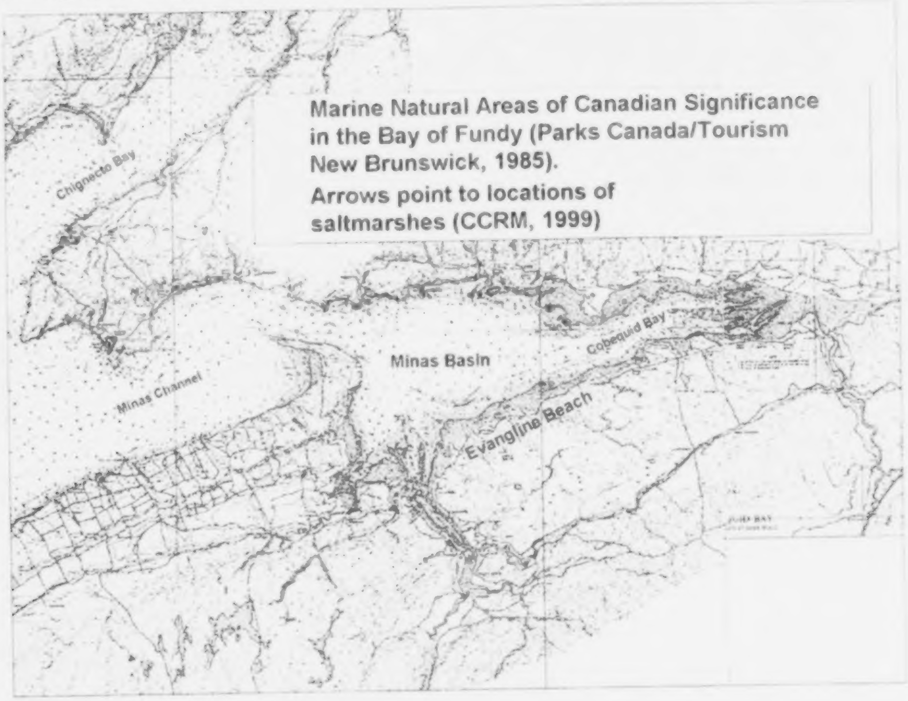

Area of high herring larvae
(Bradford & Iles, 1992).
Distribution of scallop and soft
shelled clam beds, and sea urchins
(CCRM, 1999).
Scallop beds
Soft shelled clam beds
Sea urchin areas
High herring larvae

Fig. D.4.5. Locations of salt marshes and marine Natural Area of Canadian Significance (Evangeline Beach).

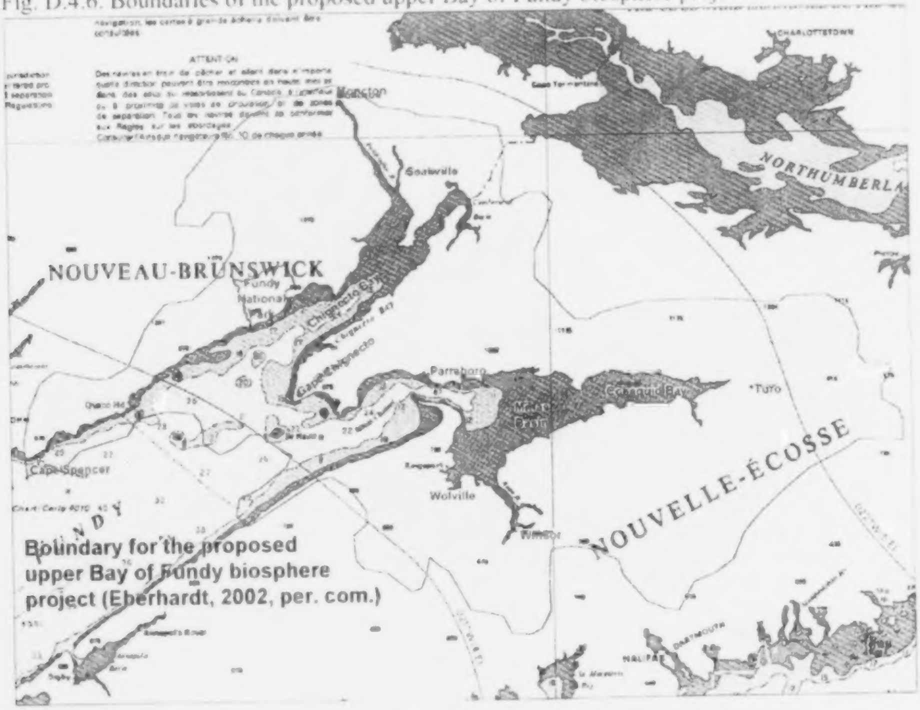


Marine Natural Areas of Canadian Significance in the Bay of Fundy (Parks Canada/Tourism New Brunswick, 1985).

Arrows point to locations of saltmarshes (CCRM, 1999)

Chignecto Bay
Minas Basin
Cobequid Bay
Minas Channel
Evangeline Beach

Fig. D.4.6. Boundaries of the proposed upper Bay of Fundy biosphere project.



Boundary for the proposed upper Bay of Fundy biosphere project (Eberhardt, 2002, per. com.)

Moncton
Charlottetown
NORTHUMBERLA
NOUVEAU-BRUNSWICK
Fundy National Park
Chignecto Bay
Parrsboro
Cobequid Bay
Truro
Cape Spencer
Wolfville
Windsor
NOUVELLE-ÉCOSSE
Halifax
Dartmouth

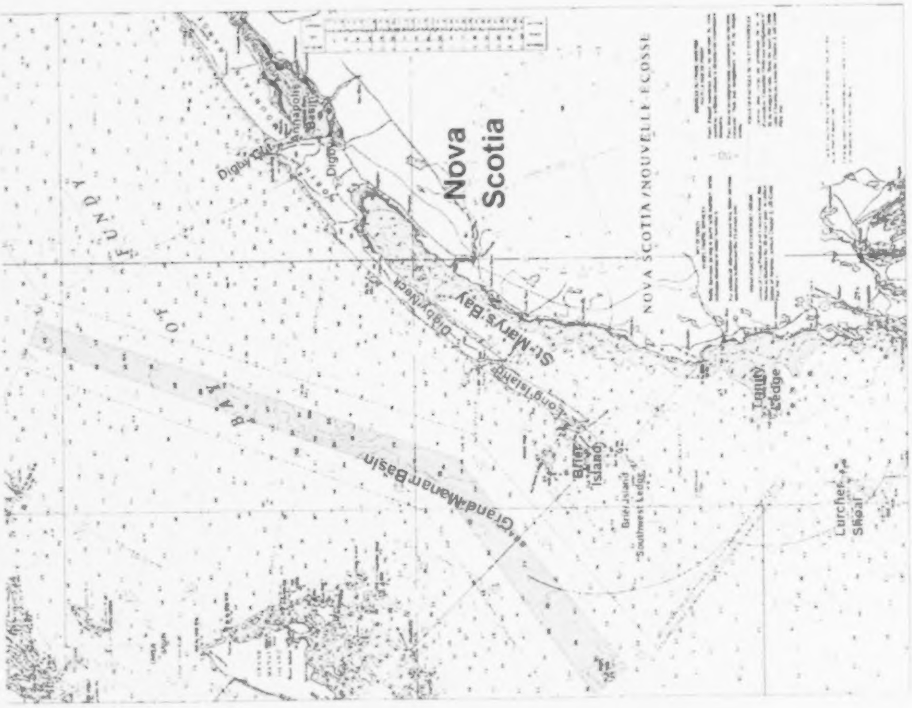

BAY OF FUNDY
Digby Gut
Annapolis Basin
Digby
Nova Scotia
Digby Neck
St. Mary's Bay
Long Island
Brier Island
Brier Island Southwest Ledge
Grand Manan Basin
Trinity Ledge
Lurcher Shoal
NOVA SCOTIA / NOUVELLE-ÉCOSSE

Fig. D.5.1. Locations of places along the Nova Scotia coast mentioned in text.

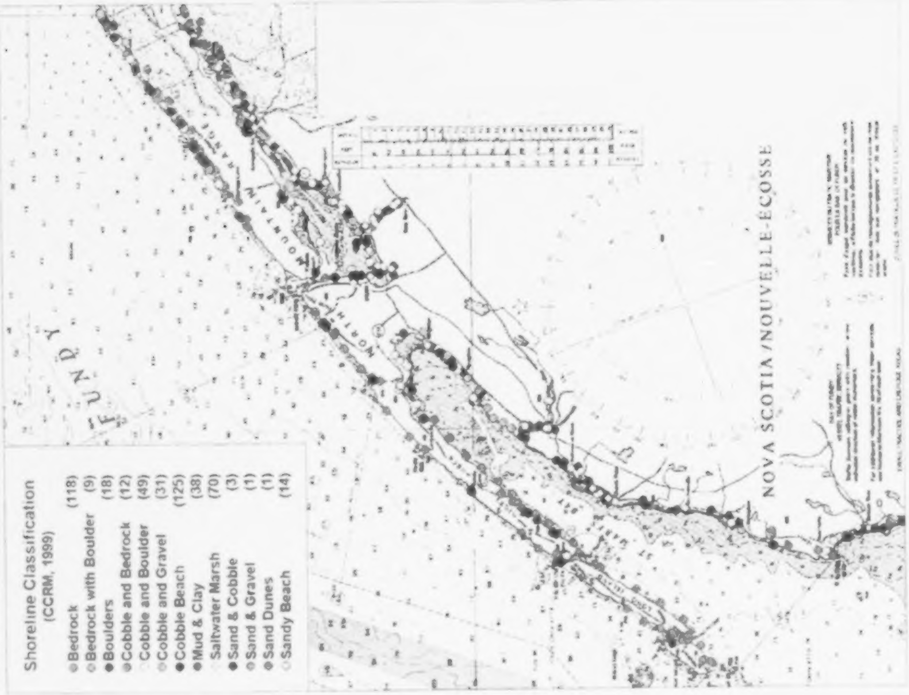

Shoreline Classification (CCRM, 1999)
Bedrock (118)
Bedrock with Boulder (9)
Boulders (18)
Cobble and Bedrock (12)
Cobble and Boulder (49)
Cobble and Gravel (31)
Cobble Beach (125)
Mud & Clay (38)
Saltwater Marsh (70)
Sand & Cobble (3)
Sand & Gravel (1)
Sand Dunes (1)
Sandy Beach (14)
FUNDY
NORTH MOUNTAIN
NOVA SCOTIA / NOUVELLE-ÉCOSSE

Fig. D.5.2. Shoreline classification for the Nova Scotia shoreline.

Fig. D.5.3. Lobster numbers from dive surveys, and fall migration pattern in Annapolis Basin.

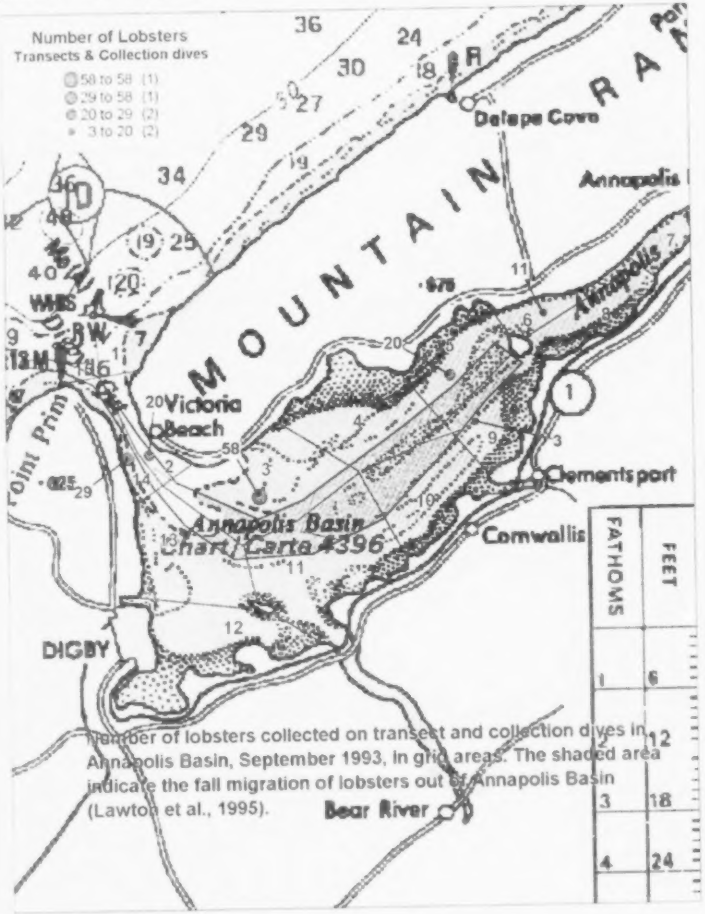

Number of Lobsters
Transects & Collection dives
58 to 58 (1)
29 to 58 (1)
20 to 29 (2)
3 to 20 (2)
MOUNTAIN RA
Delapa Cove
Annapolis
Victoria Beach
Clementsport
Cornwallis
Annapolis Basin
Chart/Carta 4396
DIGBY
Bear River
Point Prim
FATHOMS
FEET
Number of lobsters collected on transect and collection dives in Annapolis Basin, September 1993, in grid areas. The shaded area indicate the fall migration of lobsters out of Annapolis Basin (Lawton et al., 1995).

Fig. D.5.4. Total weight of macrofauna in Annapolis Basin (DFO 2002).

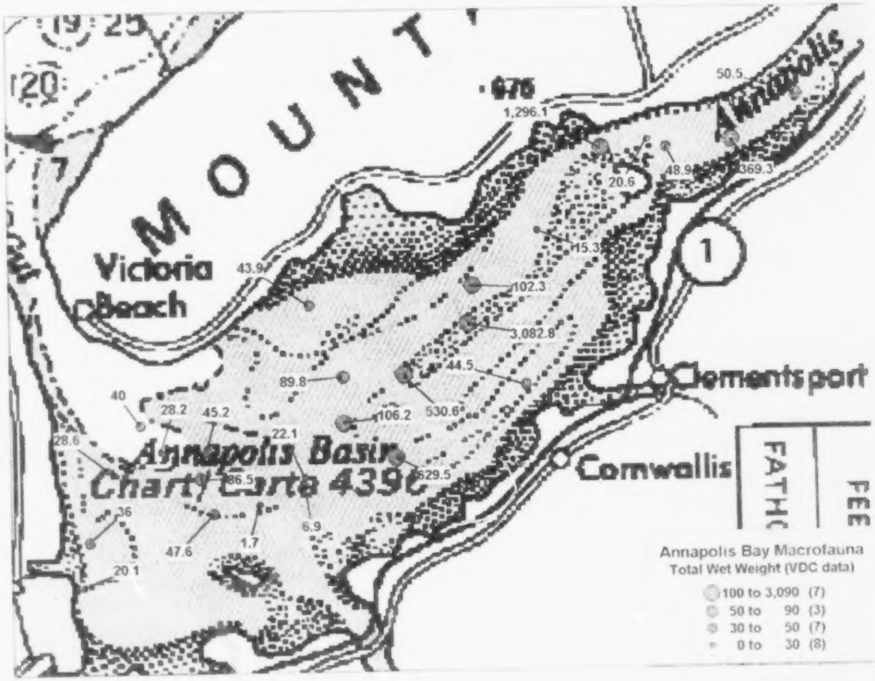
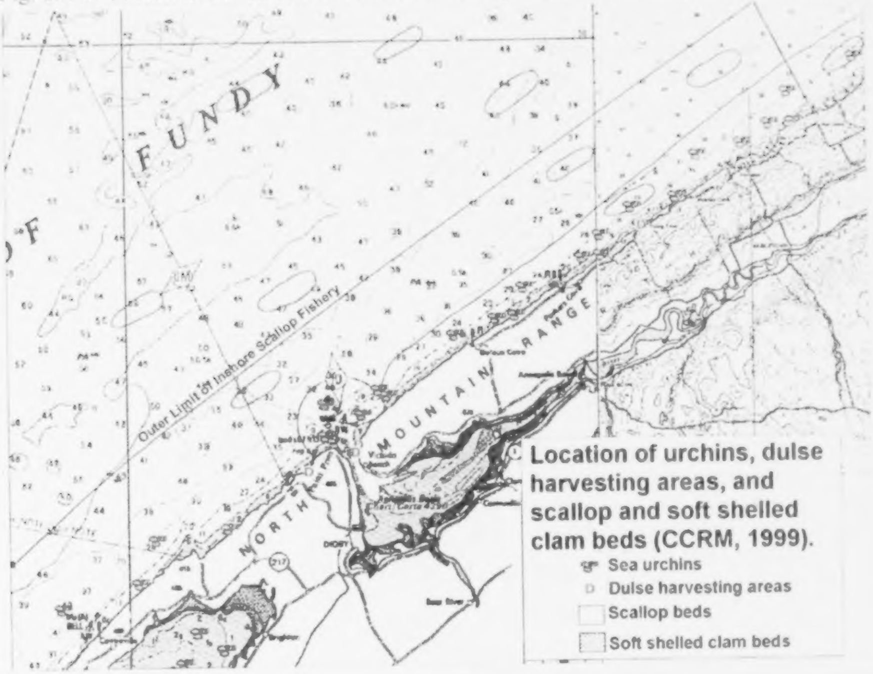

MOUNT
Victoria Beach
Annapolis
Clementsport
Cornwallis
Annapolis Basin
Chart/Carta 4396
FATH
FEE
1,296.1
50.5
369.3
48.9
20.6
15.3
102.3
3,082.8
43.9
89.8
44.5
530.6
106.2
629.5
40
28.2
45.2
22.1
28.6
86.5
36
47.6
1.7
6.9
20.1
Annapolis Bay Macrofauna
Total Wet Weight (VDC data)
100 to 3,090 (7)
50 to 90 (3)
30 to 50 (7)
0 to 30 (8)

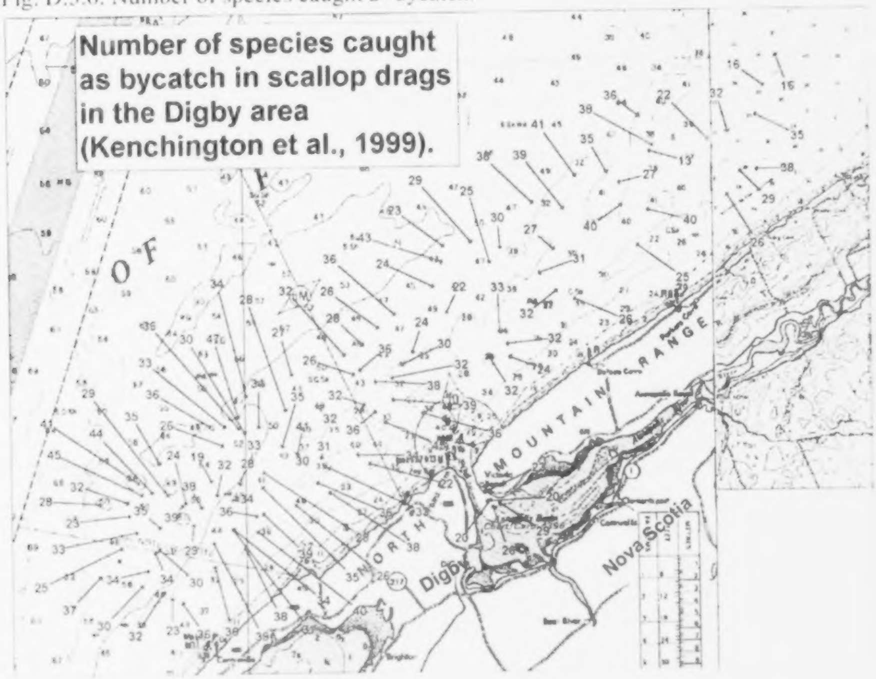
Fig. D.5.5. Locations of sea urchins, dulse harvesting areas, and scallop and soft shelled clam beds.



Location of urchins, dulse harvesting areas, and scallop and soft shelled clam beds (CCRM, 1999).

F U N D Y
OF
Outer Limit of Inshore Scallop Fishery
NORTH MOUNTAIN RANGE
Sea urchins
Dulse harvesting areas
Scallop beds
Soft shelled clam beds

Fig. D.5.6. Number of species caught as bycatch.



Number of species caught as bycatch in scallop drags in the Digby area (Kenchington et al., 1999).

OF
NORTH MOUNTAIN RANGE
Digby
Nova Scotia

Fig. D.5.7. Number of lobsters (per 1000 m^{2}) collected during dives. (Robichaud et al. 1987)

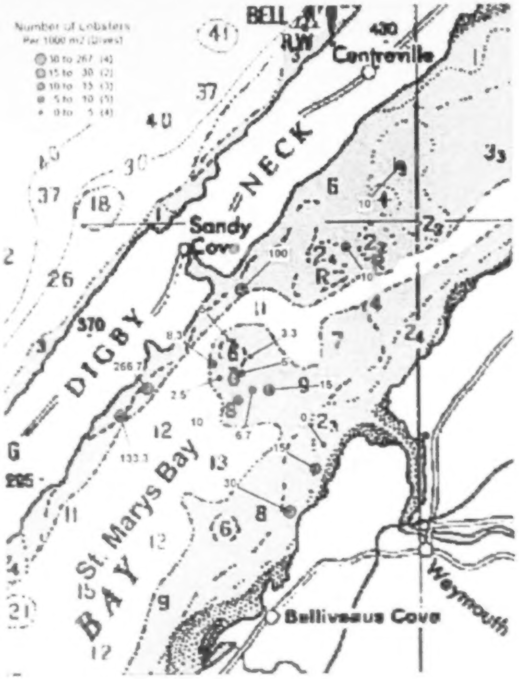

Number of Lobsters
Per 1000 m2 (Dives)
30 to 267 (4)
15 to 30 (2)
10 to 15 (3)
5 to 10 (5)
0 to 5 (4)
BELL
Centreville
Sandy Cove
DIGBY
NECK
St. Marys Bay
BAY
Belliveaus Cove
Weymouth

Fig. D.5.8. Locations of urchins, dulse harvesting areas, and scallop and soft shelled clam beds.

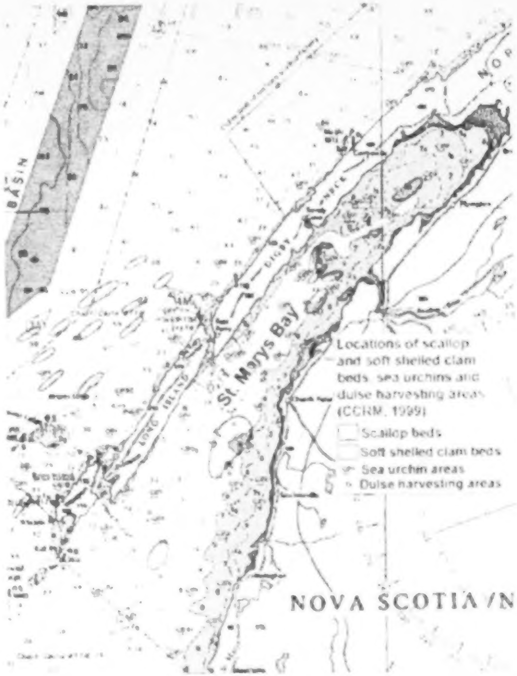

BASIN
St. Marys Bay
Locations of scallop and soft shelled clam beds, sea urchins and dulse harvesting areas (CCRM, 1999)
Scallop beds
Soft shelled clam beds
Sea urchin areas
Dulse harvesting areas
NOVA SCOTIA

Fig. D.5.9. Location of herring weirs, aquaculture sites, and seal haulouts.

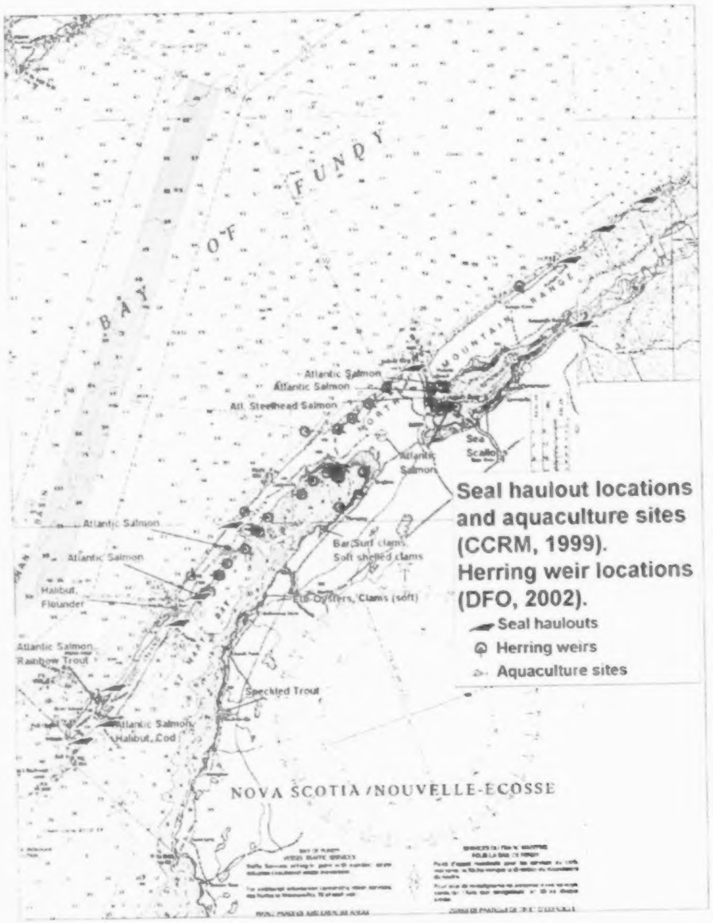

BAY OF FUNDY
NOVA SCOTIA /NOUVELLE-ECOSSE
Atlantic Salmon
Atlantic Salmon
Atl. Steelhead Salmon
Sea Scallop
Atlantic Salmon
Bar/Surf clams
Soft shelled clams
Oysters, Clams (soft)
Atlantic Salmon
Atlantic Salmon
Halibut, Flounder
Atlantic Salmon, Rainbow Trout
Atlantic Salmon, Halibut, Cod
Speckled Trout
Seal haulout locations and aquaculture sites (CCRM, 1999).
Herring weir locations (DFO, 2002).
Seal haulouts
Herring weirs
Aquaculture sites

Fig. D.5.10. Brier Island Natural Area of Canadian Significance and number of species recorded by MacKay (1977).

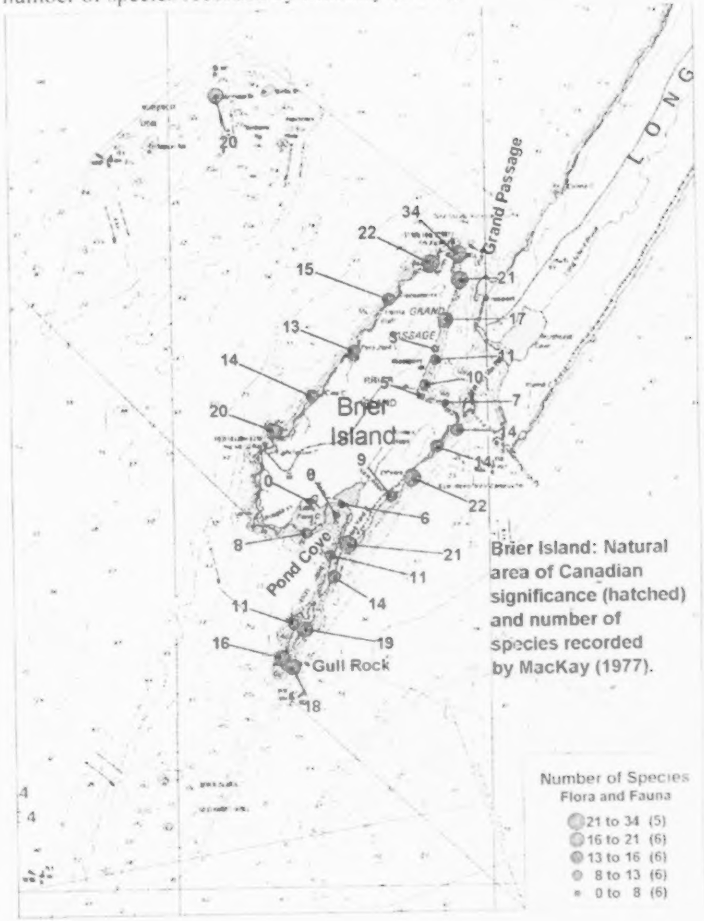

LONG
Grand Passage
Brier Island
Pond Cove
Gull Rock
34
22
15
13
14
20
21
17
11
10
7
14
14
22
9
6
0
8
8
21
11
14
11
19
16
18
20
Brier Island: Natural area of Canadian significance (hatched) and number of species recorded by MacKay (1977).
Number of Species
Flora and Fauna
21 to 34 (5)
16 to 21 (6)
13 to 16 (6)
8 to 13 (6)
0 to 8 (6)

Fig. D.5.11. General area of whale observations from 1985-1998.

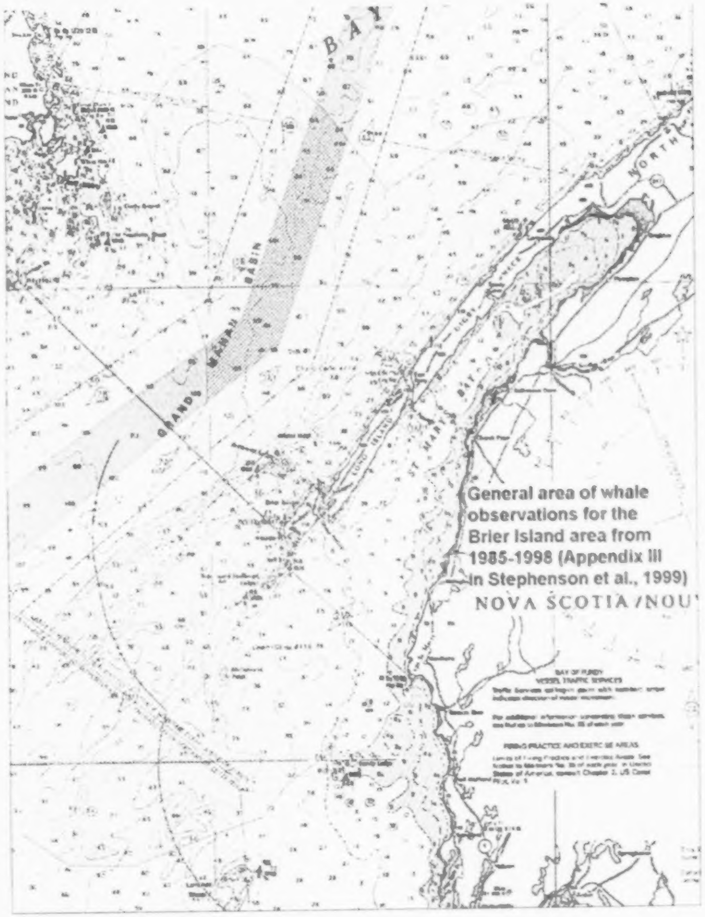

BAY
GRAND MANAN BASIN
General area of whale observations for the Brier Island area from 1985-1998 (Appendix III in Stephenson et al., 1999)
NOVA SCOTIA / NOU

Fig. D.5.12. Number of species caught as bycatch in scallop drags.

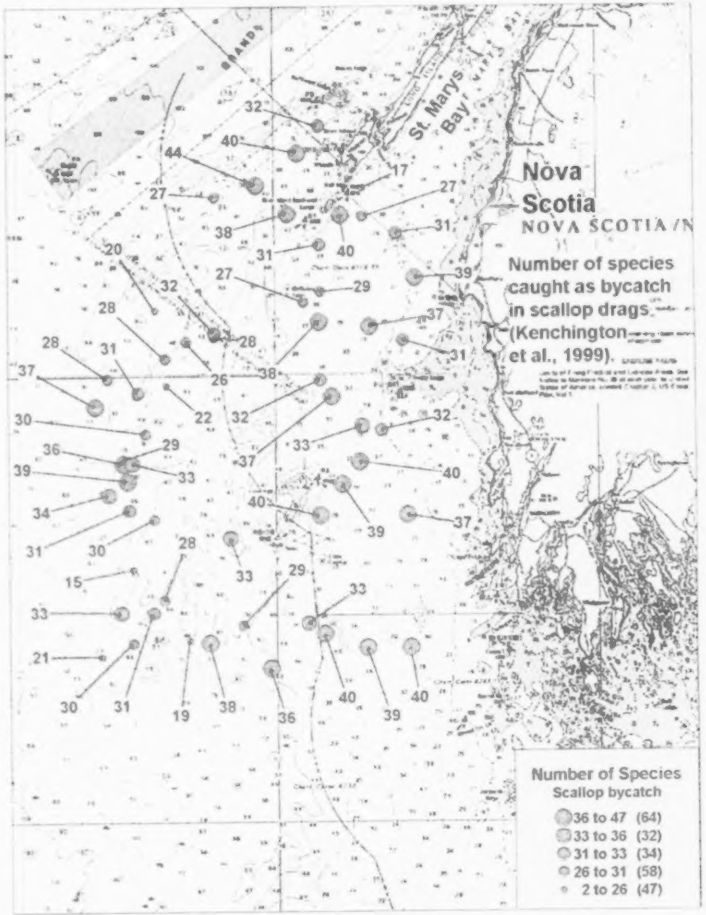

St. Marys Bay
Nova Scotia
NOVA SCOTIA / N
Number of species caught as bycatch in scallop drags (Kenchington et al., 1999).
Number of Species
Scallop bycatch
36 to 47 (64)
33 to 36 (32)
31 to 33 (34)
26 to 31 (58)
2 to 26 (47)

Fig. E.1. Distribution of high numbers of cod eggs from surveys in 1932

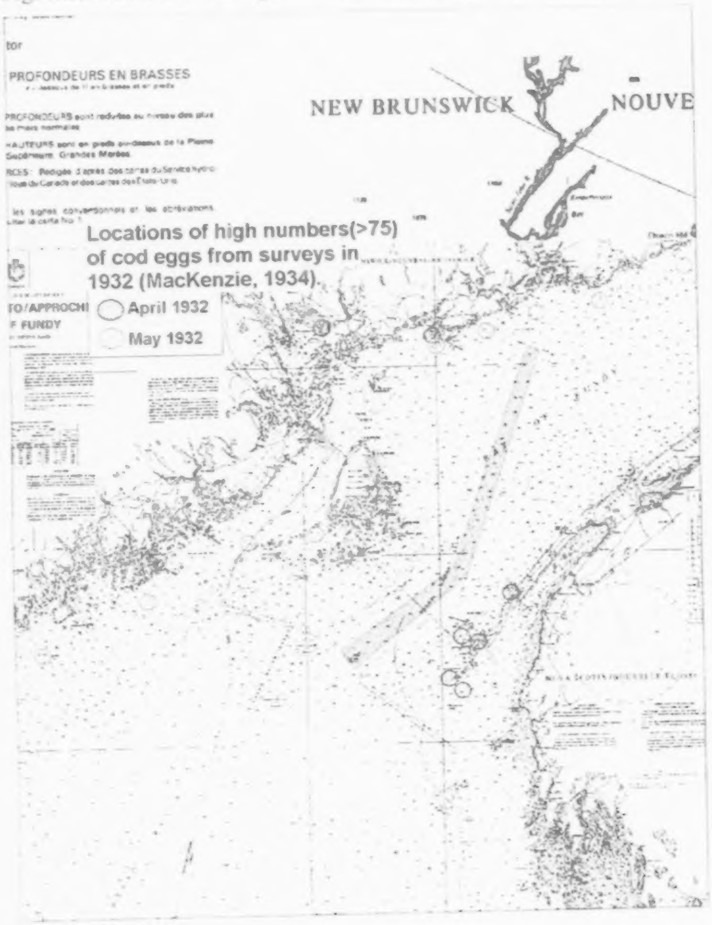

PROFONDEURS EN BRASSES
NEW BRUNSWICK
NOUVE
Locations of high numbers(>75)
of cod eggs from surveys in
1932 (MacKenzie, 1934).
April 1932
May 1932
TO/APPROCHI
F FUNDY

Fig. E.2. Spawning areas for cod and haddock.

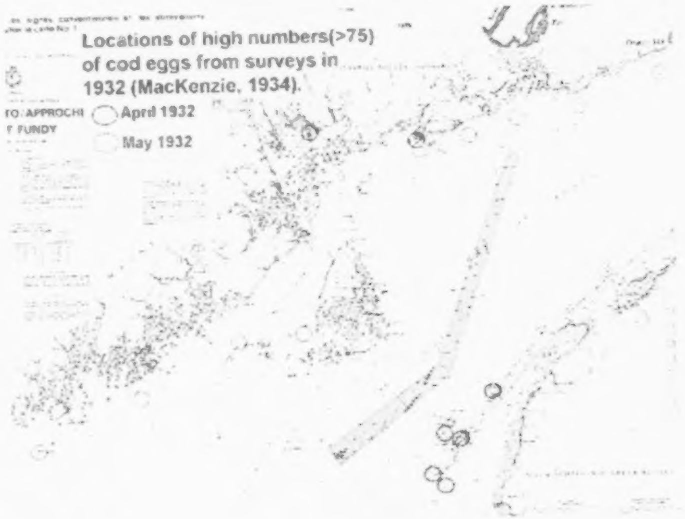

Locations of high numbers(>75)
of cod eggs from surveys in
1932 (MacKenzie, 1934).
April 1932
May 1932
TO/APPROCHI
F FUNDY

Fig. E.3. Distribution of spawning and ripe flounders from research surveys between 1970-1981.

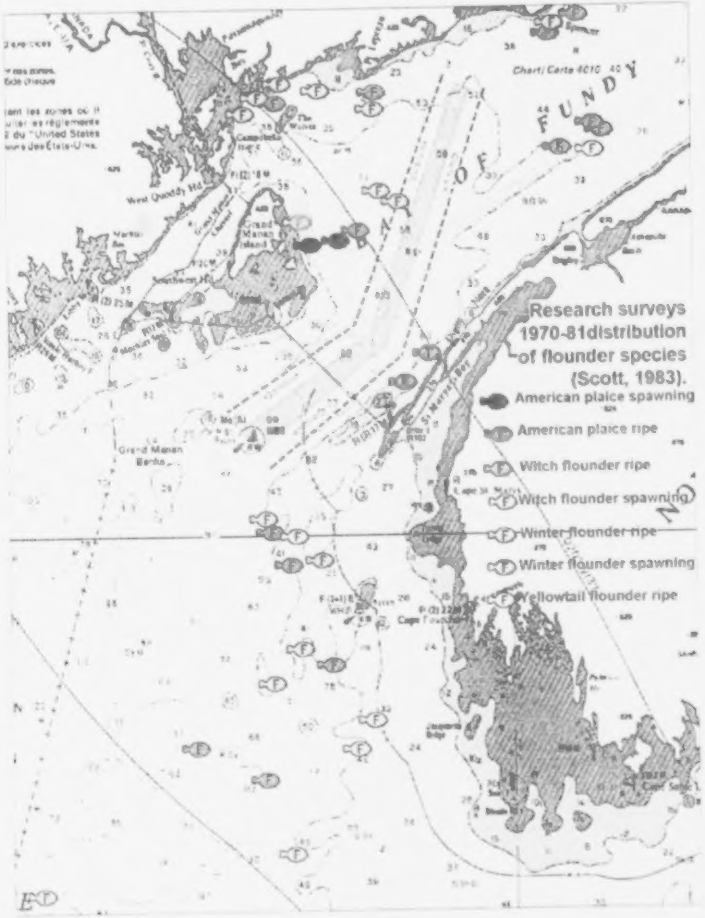

Chart/ Carte 4010
BAY OF FUNDY
Grand Manan Island
West Quoddy Hd
Grand Manan Banks
St Marys Bay
Research surveys 1970-81distribution of flounder species (Scott, 1983).
American plaice spawning
American plaice ripe
Witch flounder ripe
Witch flounder spawning
Winter flounder ripe
Winter flounder spawning
Yellowtail flounder ripe

Fig. E.4. Spawning areas of cod, herring, pollock, and lobsters.

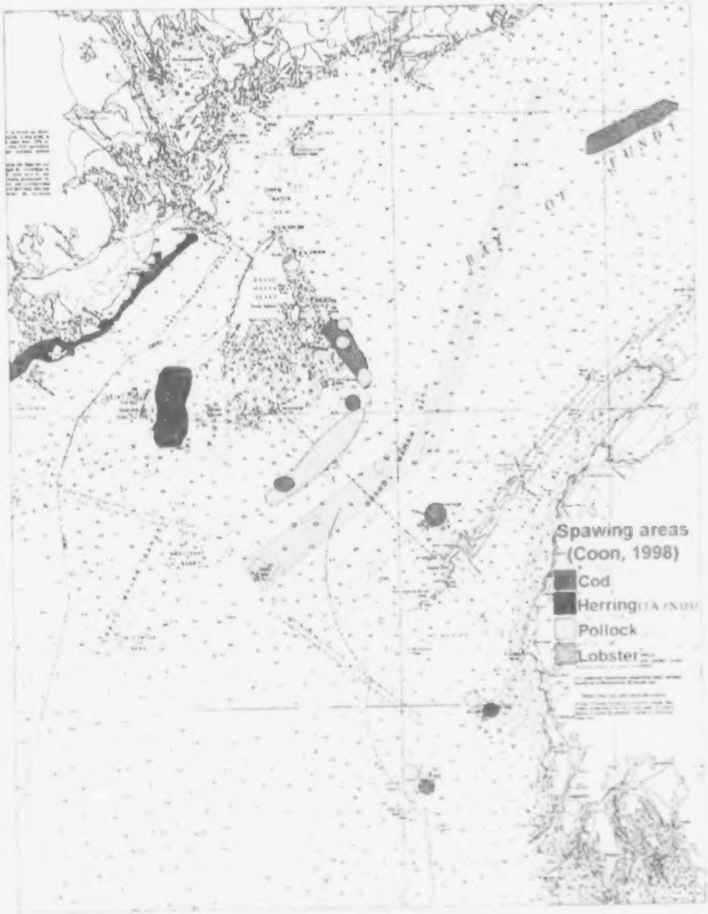

BAY OF FUNDY
Spawing areas (Coon, 1998)
Cod
Herring
Pollock
Lobster

Fig. E.5. Location of known herring spawning areas, current (solid) and historical (open) spawning locations in the Bay of Fundy.

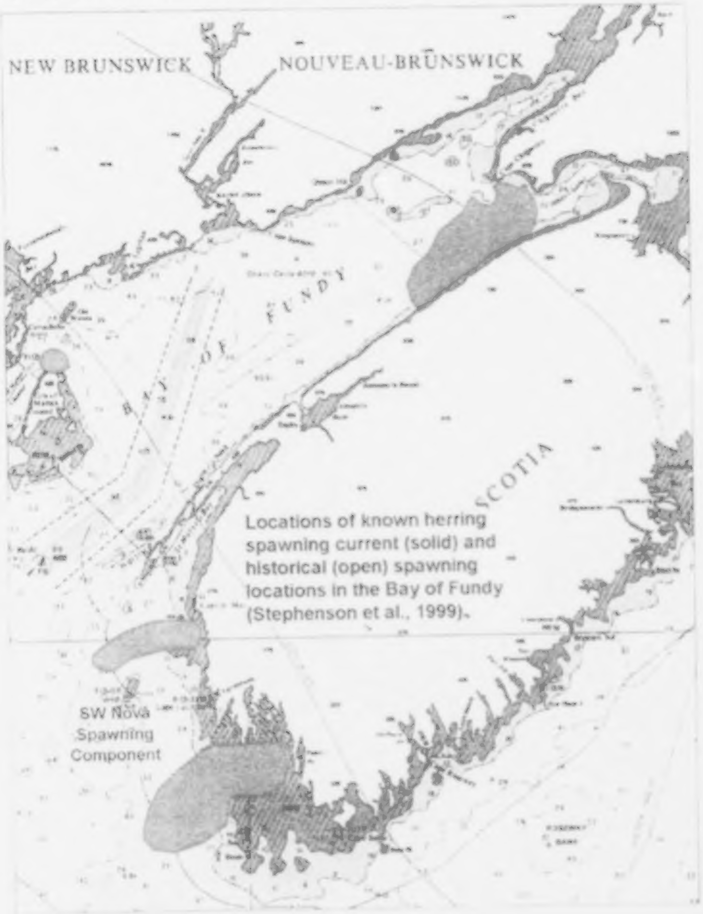

NEW BRUNSWICK
NOUVEAU-BRUNSWICK
BAY OF FUNDY
SCOTIA
Locations of known herring spawning current (solid) and historical (open) spawning locations in the Bay of Fundy (Stephenson et al., 1999).
SW Nova Spawning Component

Fig. E.6. Spawning pollock distribution based on numbers m of eggs and larvae American and Canadian ichthyoplankton surveys.

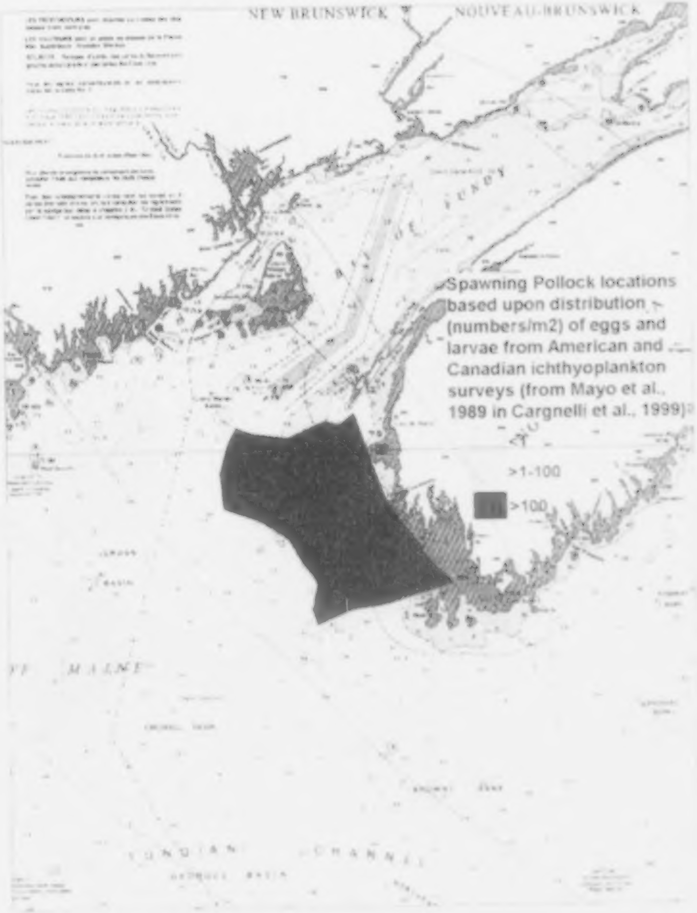
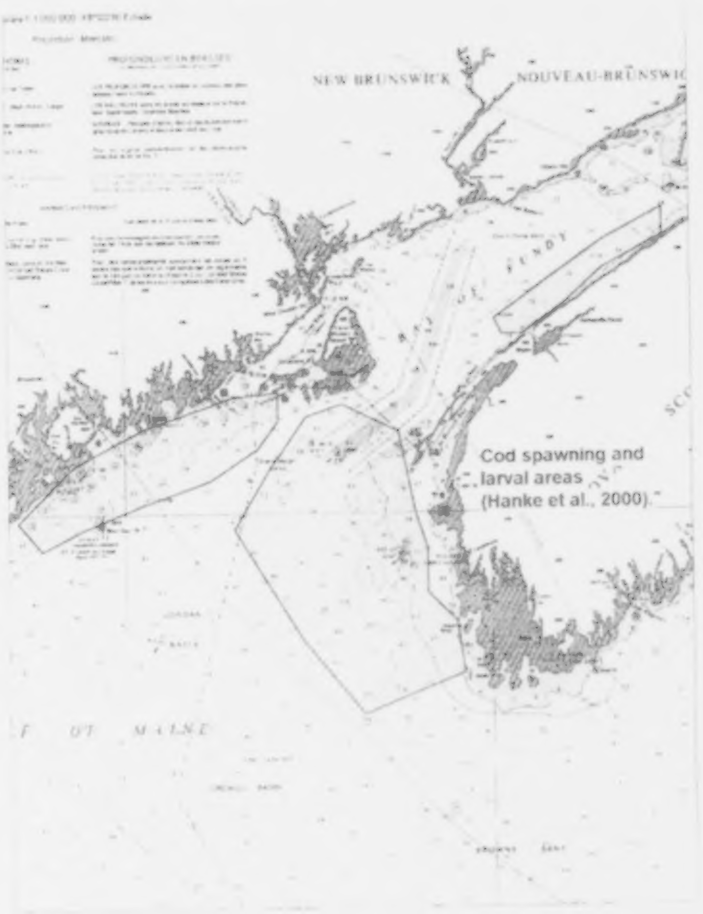

NEW BRUNSWICK
NOUVEAU-BRUNSWICK
BAY OF FUNDY
Spawning Pollock locations based upon distribution (numbers/m2) of eggs and larvae from American and Canadian ichthyoplankton surveys (from Mayo et al., 1989 in Cargnelli et al., 1999)
>1-100
>100
MAINE
FUNDIAN CHANNEL

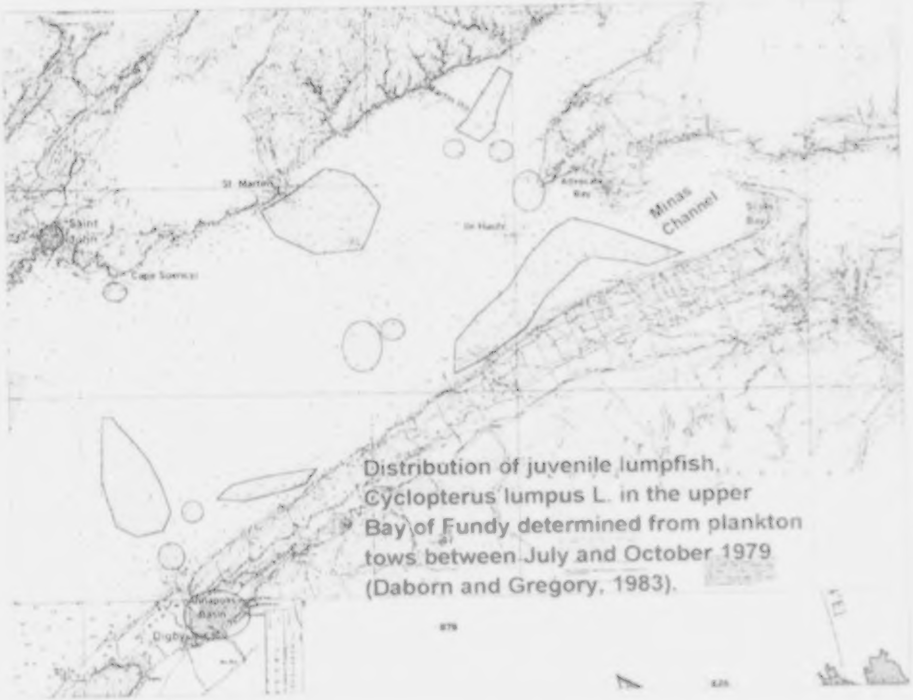
Fig. E.7. Cod spawning and larval areas.



NEW BRUNSWICK
NOUVEAU-BRUNSWICK
BAY OF FUNDY
OF MAINE

Cod spawning and larval areas (Hanke et al., 2000).

Fig. E.8. Distribution of juvenile lumpfish in the upper Bay of Fundy from July-October 1979.



Saint John
St. Martins
Cape Spencer
Advocate Bay
Minas Channel
Annapolis Basin
Digby

Distribution of juvenile lumpfish, Cyclopterus lumpus L. in the upper Bay of Fundy determined from plankton tows between July and October 1979 (Daborn and Gregory, 1983).

Fig. E.9. Spatial patterns of finfish diversity in summer tows 1990-1993 and distribution of horse mussel *Modiolus modiolus*.

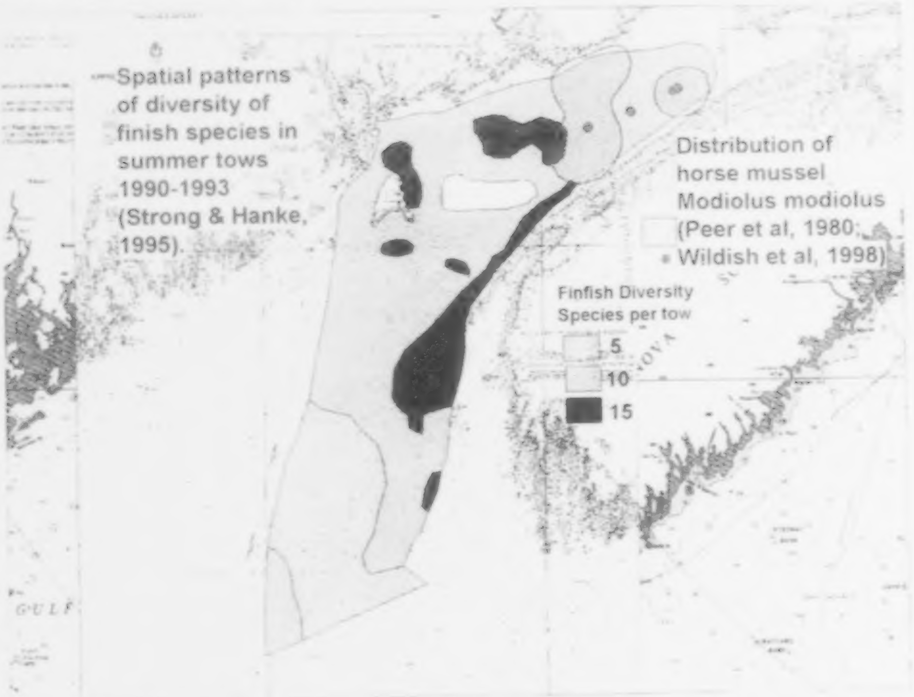

Spatial patterns of diversity of finish species in summer tows 1990-1993 (Strong & Hanke, 1995).
Distribution of horse mussel Modiolus modiolus (Peer et al, 1980; Wildish et al, 1998)
Finfish Diversity Species per tow
5
10
15
GULF

Fig. E.10. Marine Natural Areas of Canadian Significance in the Bay of Fundy.

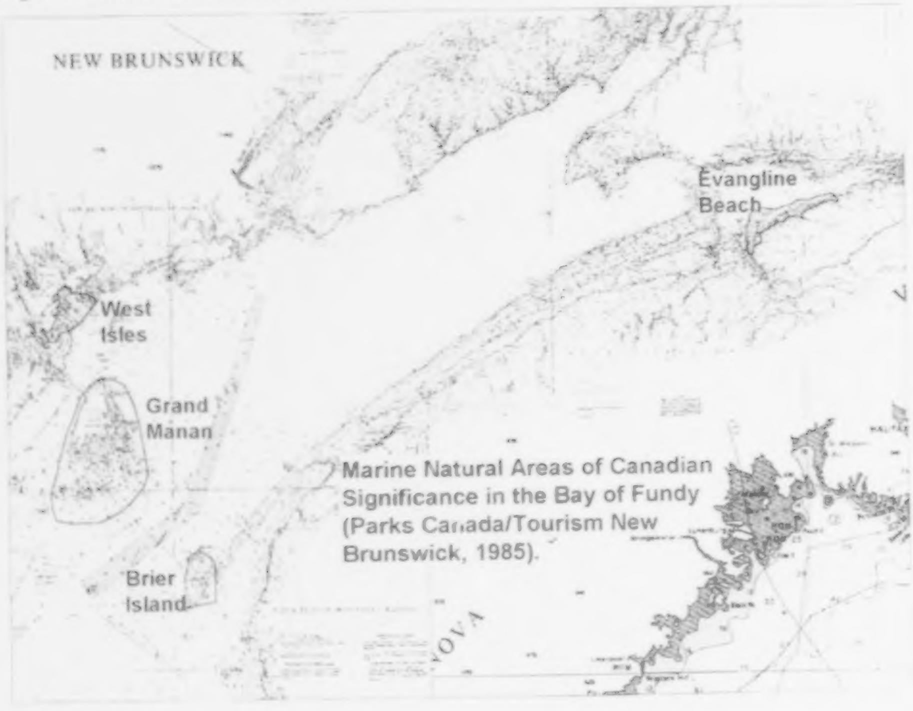

NEW BRUNSWICK
Evangline Beach
West Isles
Grand Manan
Brier Island
Marine Natural Areas of Canadian Significance in the Bay of Fundy (Parks Canada/Tourism New Brunswick, 1985).
NOVA

Fig. E.11. Seabird colonies within 5 km of Bay of Fundy shores.

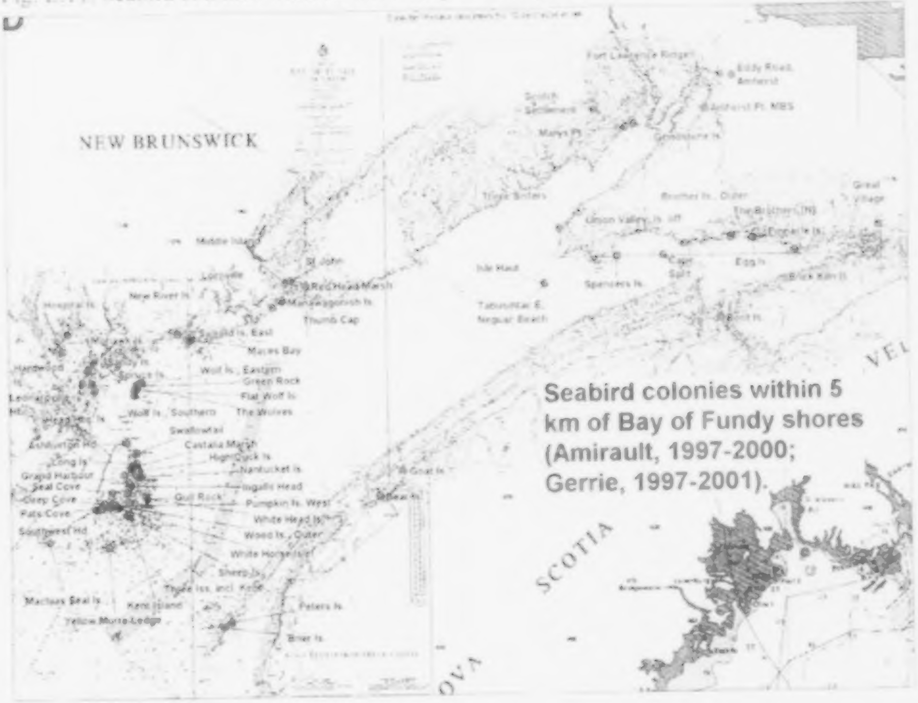

NEW BRUNSWICK
Fort Lawrence Ridge
Eddy Road, Amherst
Scotch Settlement
Amherst Pt. MBS
Marys Pt
Grindstone Is.
Great Village
Brothers Is., Outer
The Brothers (N)
Union Valley Is. off
Middle Island
Five Sisters
St John
Lorneville
Red Head Marsh
Manawagonish Is.
Thumb Cap
New River Is.
Hospital Is.
Isle Haut
Spencers Is.
Cape Split
Egg Is.
Black Rock
Tabusintac E. Neguac Beach
Sugar Is., East
Maces Bay
Wolf Is., Eastern
Green Rock
Flat Wolf Is.
Wolf Is., Southern
The Wolves
Swallowtail
Castalia Marsh
Ashburton Hd
Long Is.
Grand Harbour
Seal Cove
Deep Cove
Pats Cove
Southwest Hd
High Duck Is.
Nantucket Is.
Ingalls Head
Gull Rock
Pumpkin Is. West
White Head Is.
Wood Is., Outer
White Horse Is.
Goat Is.
Bear Is.
Sheep Is.
Three Iss. incl. Kent
Machias Seal Is.
Kent Island
Yellow Murre Ledge
Peters Is.
Brier Is.
Seabird colonies within 5 km of Bay of Fundy shores (Amirault, 1997-2000; Gerrie, 1997-2001).
SCOTIA
NOVA
VEL

Fig. E.12. Areas of importance to coastal shorebirds in the Bay of Fundy.

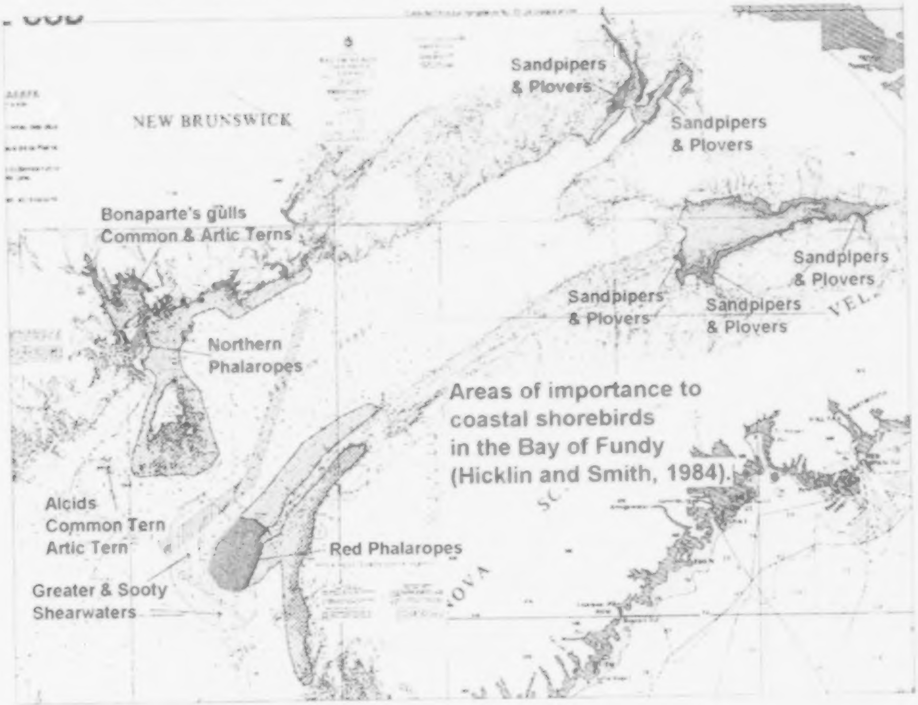

NEW BRUNSWICK
Sandpipers & Plovers
Sandpipers & Plovers
Bonaparte's gulls
Common & Artic Terns
Sandpipers & Plovers
Sandpipers & Plovers
Sandpipers & Plovers
Northern Phalaropes
Areas of importance to coastal shorebirds in the Bay of Fundy (Hicklin and Smith, 1984).
Alcids
Common Tern
Artic Tern
Red Phalaropes
Greater & Sooty Shearwaters
NOVA
SC
VEL

Fig. E.13. Areas of importance to waterfowl in the Bay of Fundy.

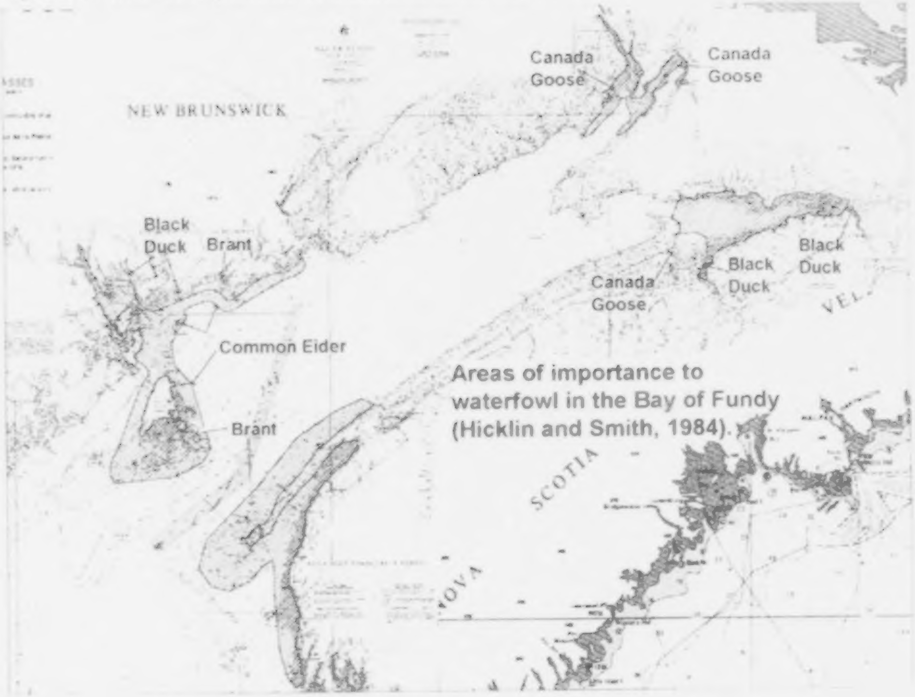

Canada Goose
Canada Goose
NEW BRUNSWICK
Black Duck
Brant
Black Duck
Black Duck
Canada Goose
Common Eider
Areas of importance to waterfowl in the Bay of Fundy (Hicklin and Smith, 1984).
Brant
SCOTIA
NOVA

Fig. E.14. Significant Avifauna areas. Important bird areas in the Bay of Fundy.

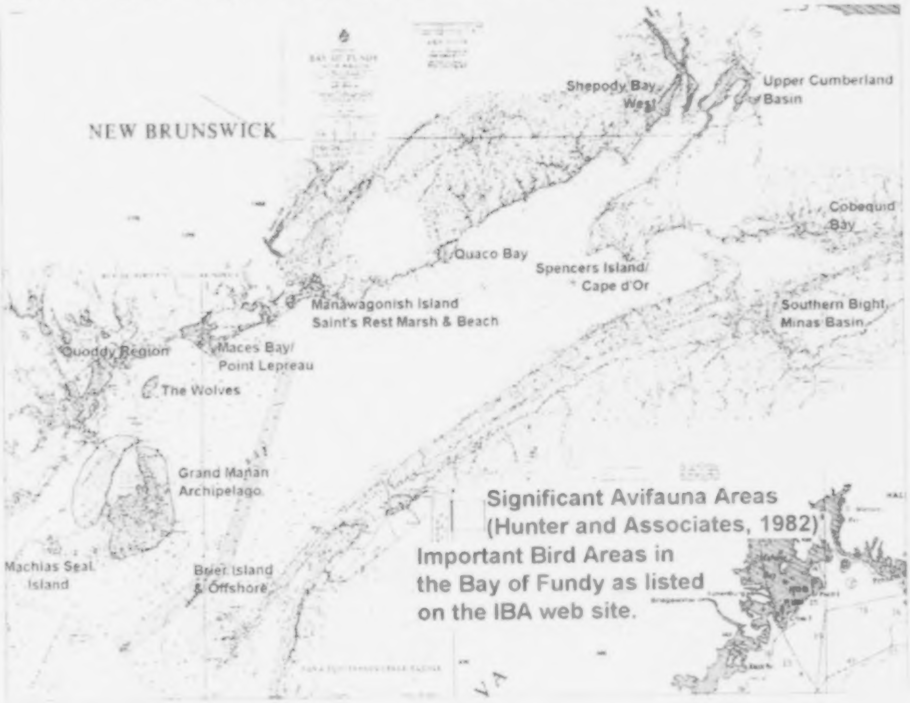

Shepody Bay West
Upper Cumberland Basin
NEW BRUNSWICK
Cobequid Bay
Quaco Bay
Spencers Island/ Cape d'Or
Manawagonish Island
Saint's Rest Marsh & Beach
Southern Bight, Minas Basin
Quoddy Region
Maces Bay/ Point Lepreau
The Wolves
Grand Manan Archipelago
Significant Avifauna Areas (Hunter and Associates, 1982)
Important Bird Areas in the Bay of Fundy as listed on the IBA web site.
Machias Seal Island
Brier Island & Offshore
VA

Fig. E.15. Areas proposed as ecological reserves.

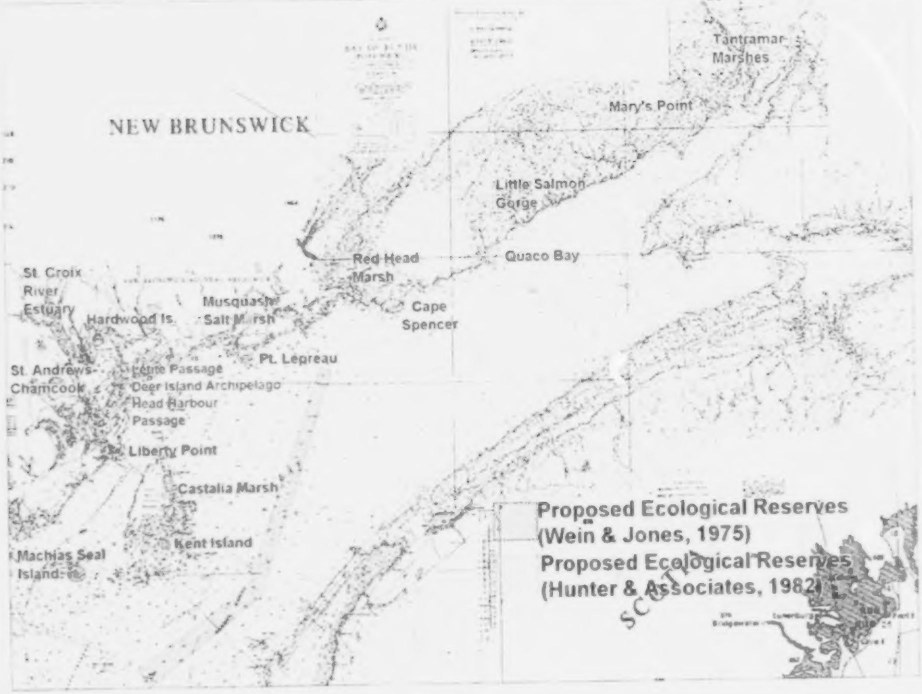
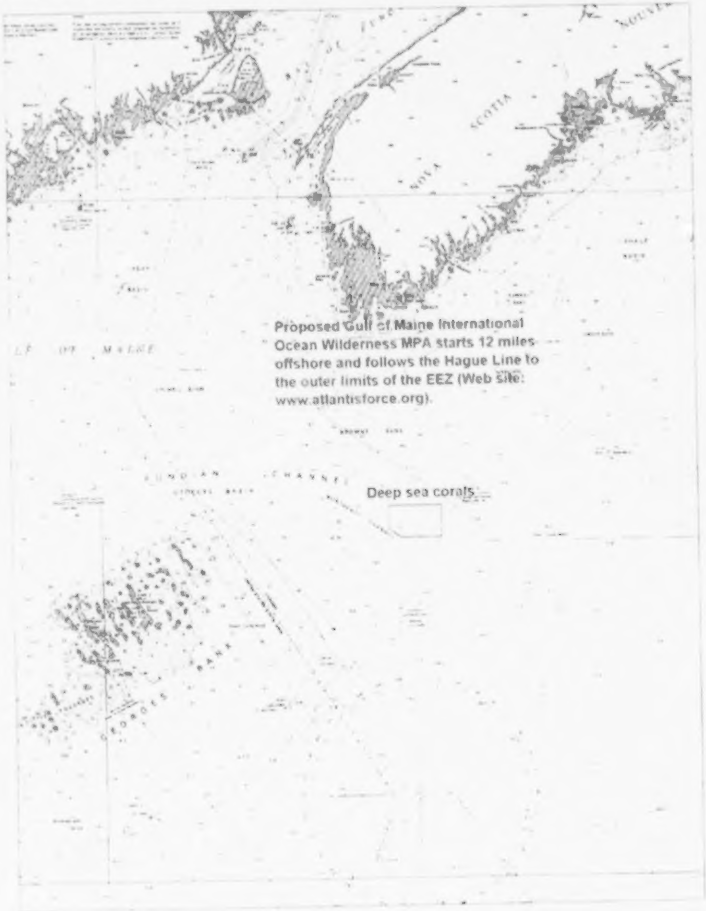

NEW BRUNSWICK
Tantramar Marshes
Mary's Point
Little Salmon Gorge
Quaco Bay
Red Head Marsh
Cape Spencer
St. Croix River Estuary
Hardwood Is.
Musquash Salt Marsh
Pt. Lepreau
St. Andrews-Chamcook
Letite Passage
Deer Island Archipelago
Head Harbour Passage
Liberty Point
Castalia Marsh
Kent Island
Machias Seal Island
Proposed Ecological Reserves (Wein & Jones, 1975)
Proposed Ecological Reserves (Hunter & Associates, 1982)

Fig. E.16. Marine International Ocean Wilderness MPA proposed by Atlantisforce organization.

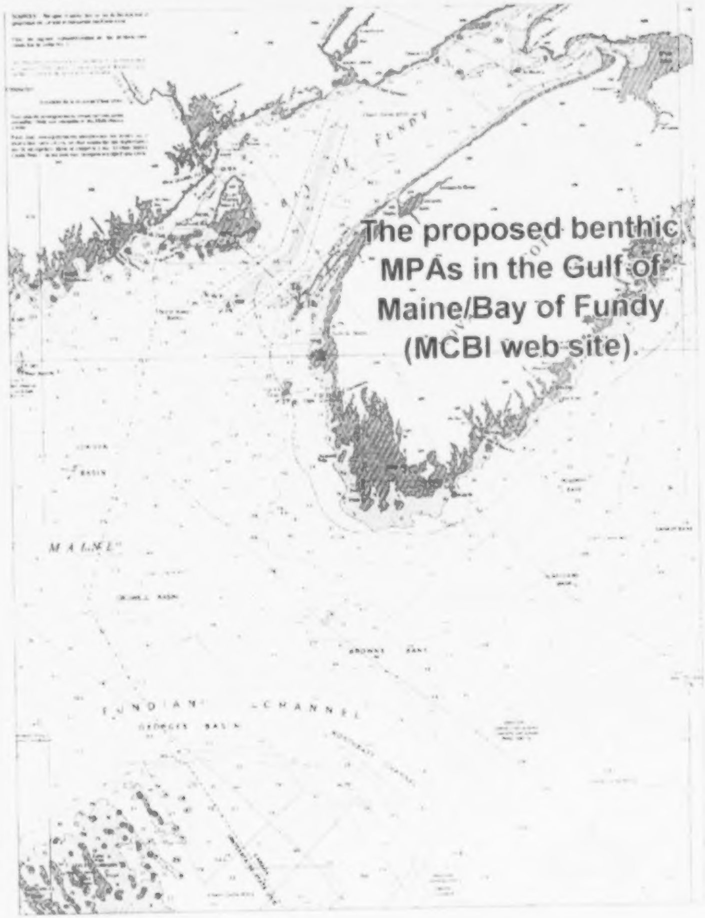


Proposed Gulf of Maine International Ocean Wilderness MPA starts 12 miles offshore and follows the Hague Line to the outer limits of the EEZ (Web site: www.atlantisforce.org).

Deep sea corals

NOVA SCOTIA
GULF OF MAINE
BROWNS BANK
FUNDIAN CHANNEL
GEORGES BASIN
GEORGES BANK

Fig. E.17. Areas proposed as benthic MPAs by Marine Conservation Biology Institute (1999).



The proposed benthic MPAs in the Gulf of Maine/Bay of Fundy (MCBI web site).

BAY OF FUNDY
MAINE
BROWNS BANK
FUNDIAN CHANNEL
GEORGES BASIN

Fig. F.1. Areas summarized in this document with references that specifically call for protection. NACS=Natural Areas of Canadian Significance. IMMA=International Marine Mammal Association. MCBI=Marine Conservation Biology Institute. GOM-IW=Gulf of Maine International Wilderness.

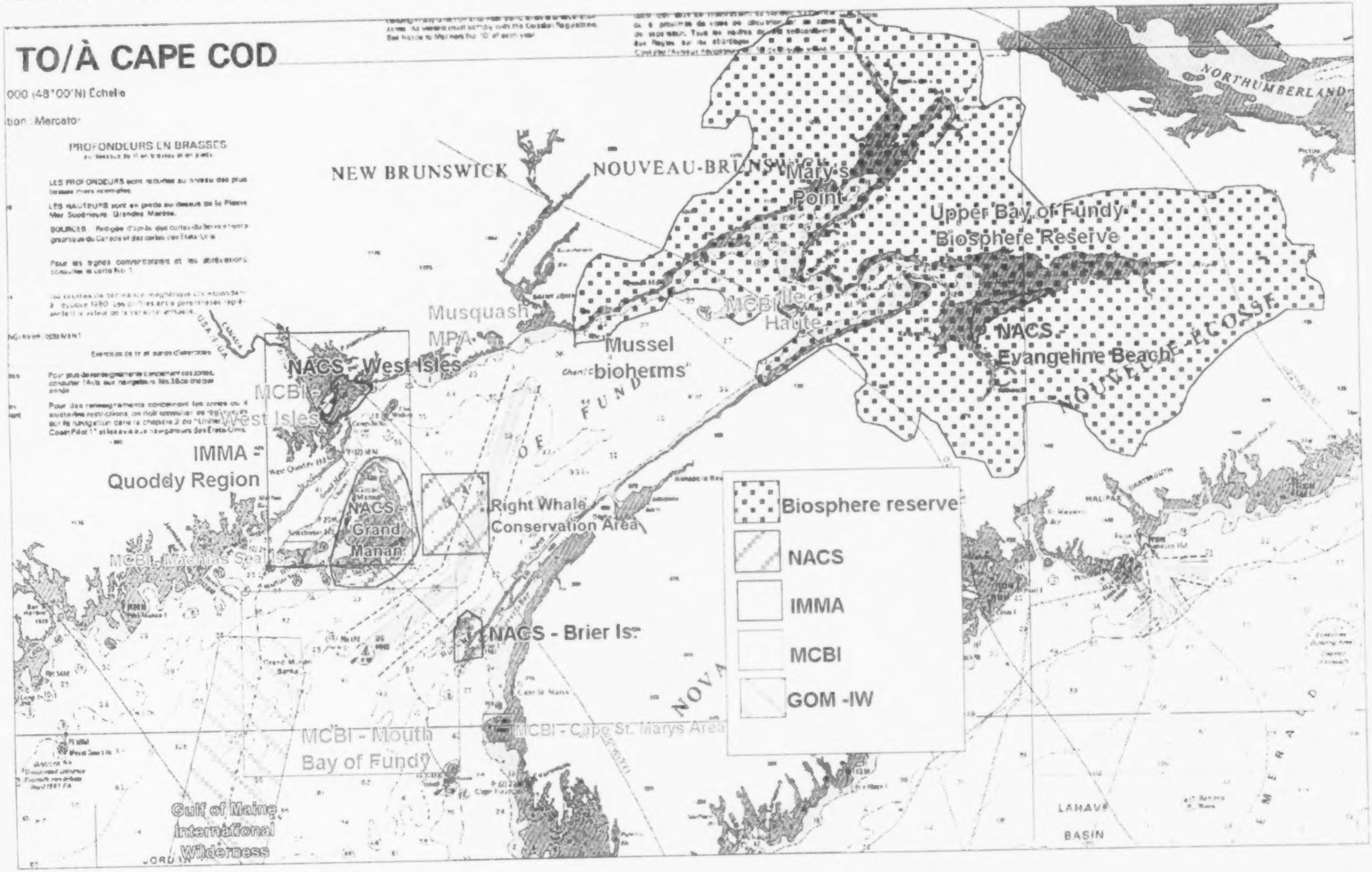

TO/À CAPE COD
PROFONDEURS EN BRASSES
NEW BRUNSWICK
NOUVEAU-BRUNSWICK
NORTHUMBERLAND
Mary's Point
Upper Bay of Fundy Biosphere Reserve
MCBI-Ile Haute
NACS - Evangeline Beach
NOUVELLE-ÉCOSSE
Musquash MPA
Mussel bioherms
NACS - West Isles
MCBI - West Isles
IMMA - Quoddy Region
NACS Grand Manan
Right Whale Conservation Area
MCBI - Machias Seal Is.
NACS - Brier Is.
NOVA
MCBI - Cape St. Marys Area
MCBI - Mouth Bay of Fundy
Gulf of Maine International Wilderness
LAHAVE BASIN
Biosphere reserve
NACS
IMMA
MCBI
GOM -IW

Fig. H.1.a. Seaweed research sites on Grand Manan (Chopin et al, 2001).

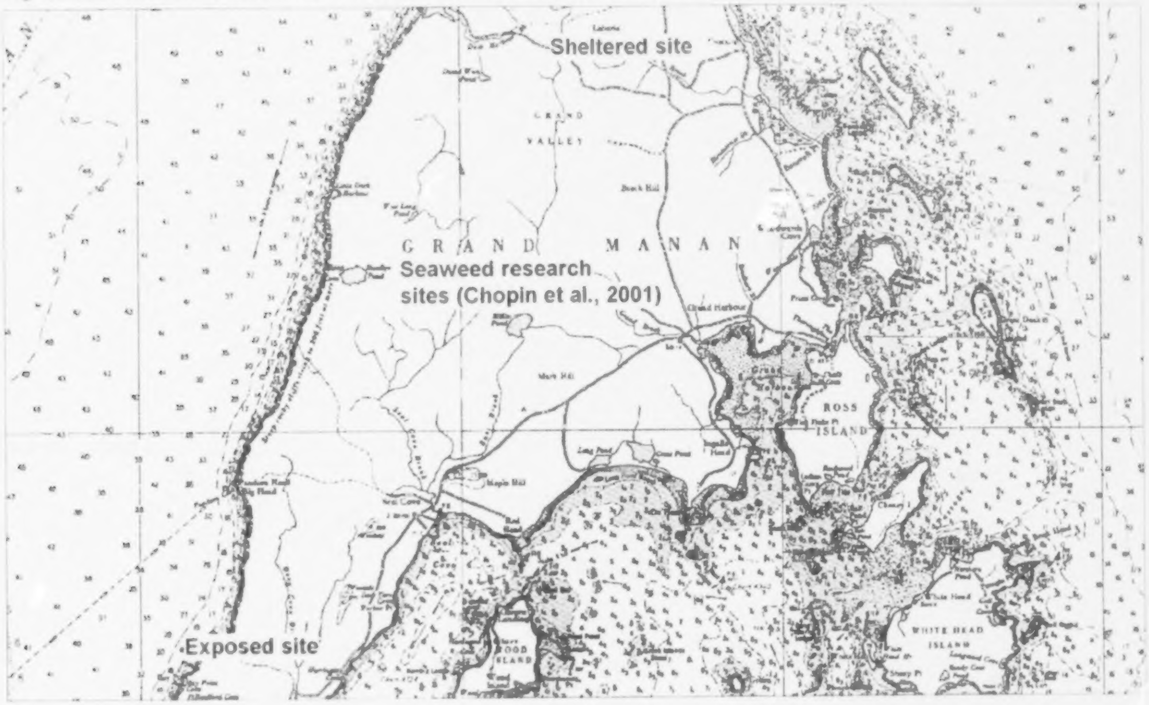

Sheltered site
GRAND VALLEY
GRAND MANAN
Seaweed research sites (Chopin et al., 2001)
ROSS ISLAND
WOOD ISLAND
WHITE HEAD ISLAND
Exposed site

Fig. H.1.b. Location of seaweed research sites at Green's Point.

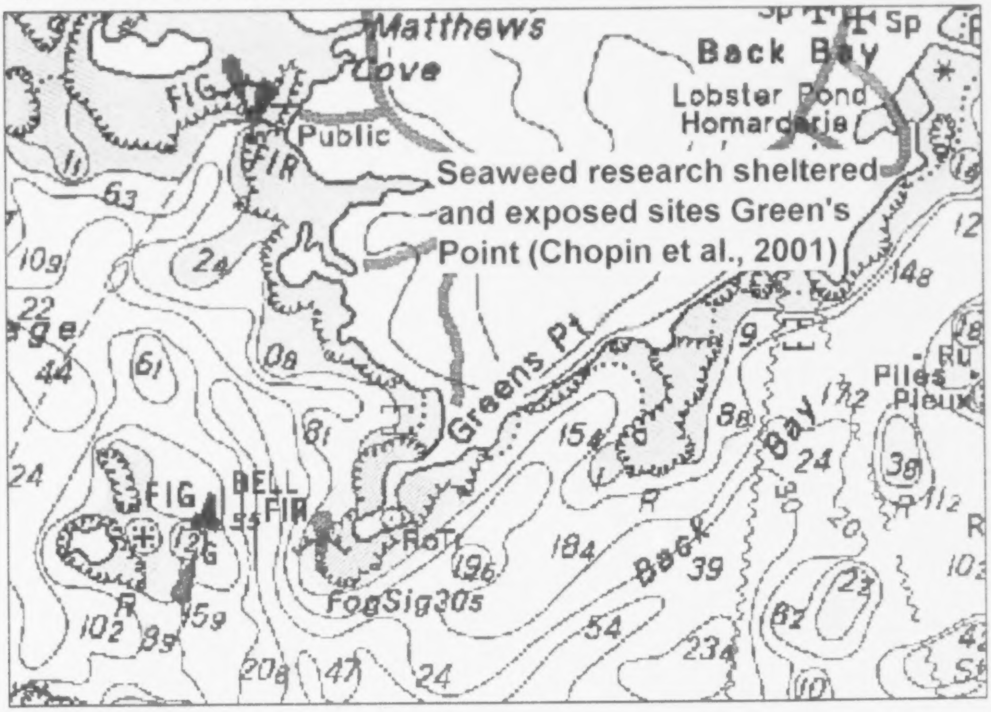

Matthews Cove
Back Bay
Lobster Pond
Homarderie
Public
Seaweed research sheltered and exposed sites Green's Point (Chopin et al., 2001)
Greens Pt
FIG
FIR
BELL
FogSig30s
Piles
Pieux
Back Bay

Fig. H.1.c. Location of seaweed research sites in Maces Bay.

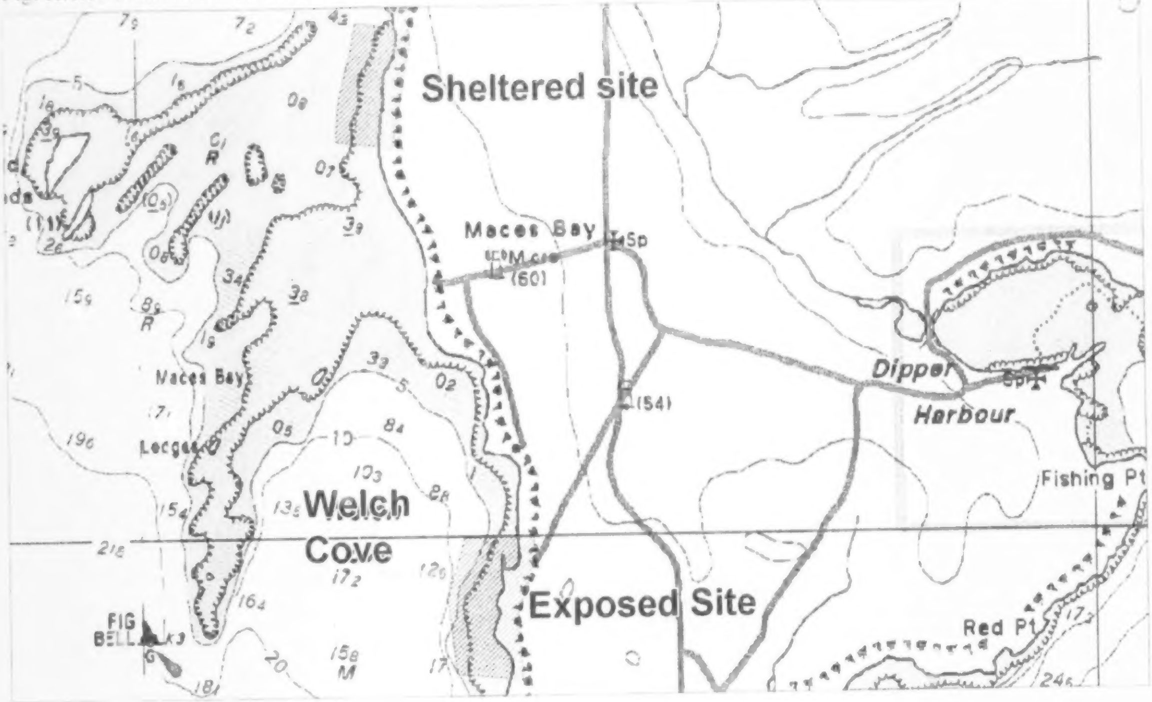

Sheltered site
Maces Bay
Maces Bay
Ledges
Welch Cove
Exposed Site
Dipper Harbour
Fishing Pt
Red Pt
FIG BELL

Fig. H.2. Areas identified as being important to seabirds.

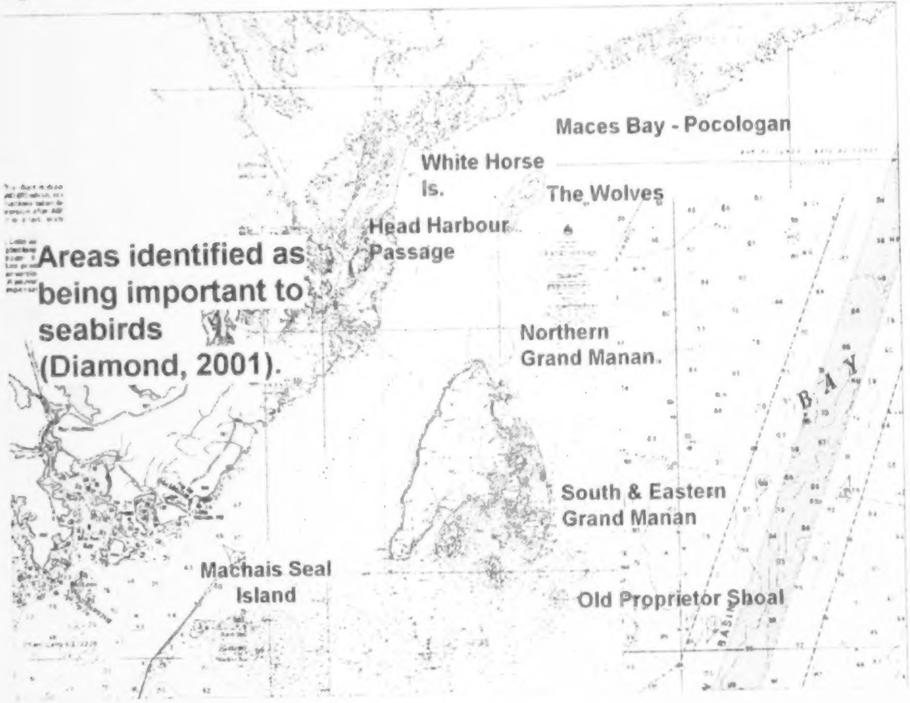

Maces Bay - Pocologan
White Horse Is.
The Wolves
Head Harbour Passage
Areas identified as being important to seabirds (Diamond, 2001).
Northern Grand Manan.
South & Eastern Grand Manan
Machais Seal Island
Old Proprietor Shoal
BAY

Fig. II.3.a. Significant area - Little Letite Passage.

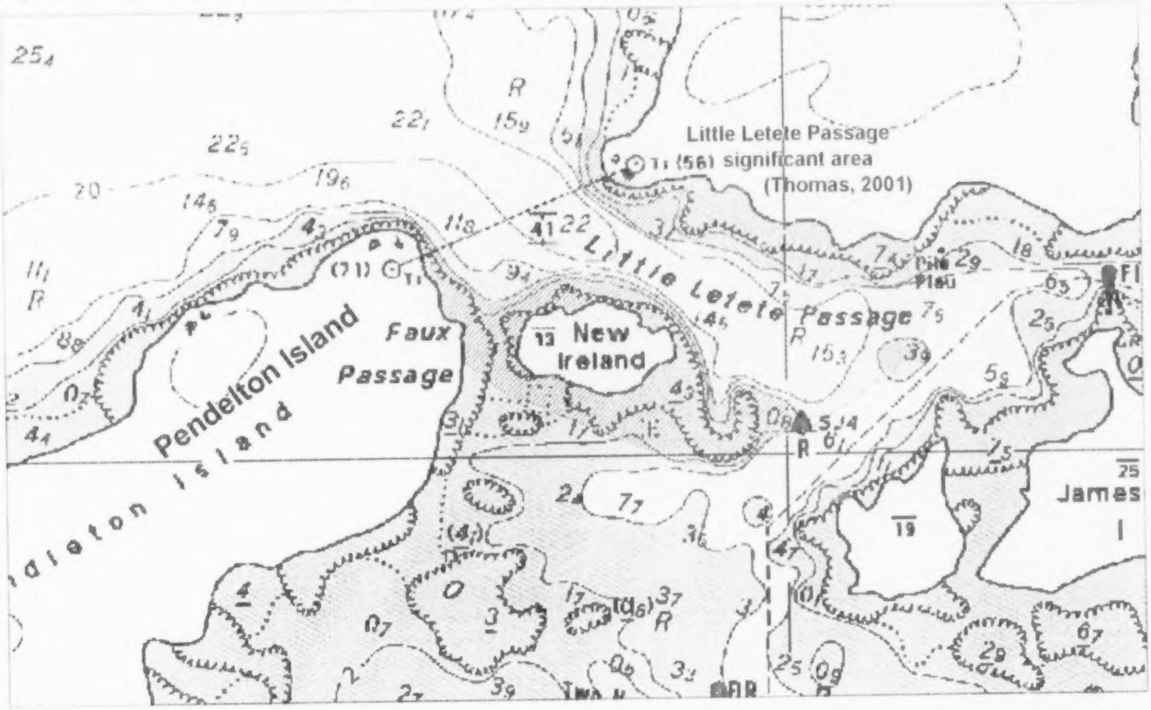

Little Letete Passage
significant area
(Thomas, 2001)
Little Letete Passage
Faux
Passage
New
Ireland
Pendelton Island
Pendelton Island
James
I

Fig. II.3.b. Significant area - Musquash Head.

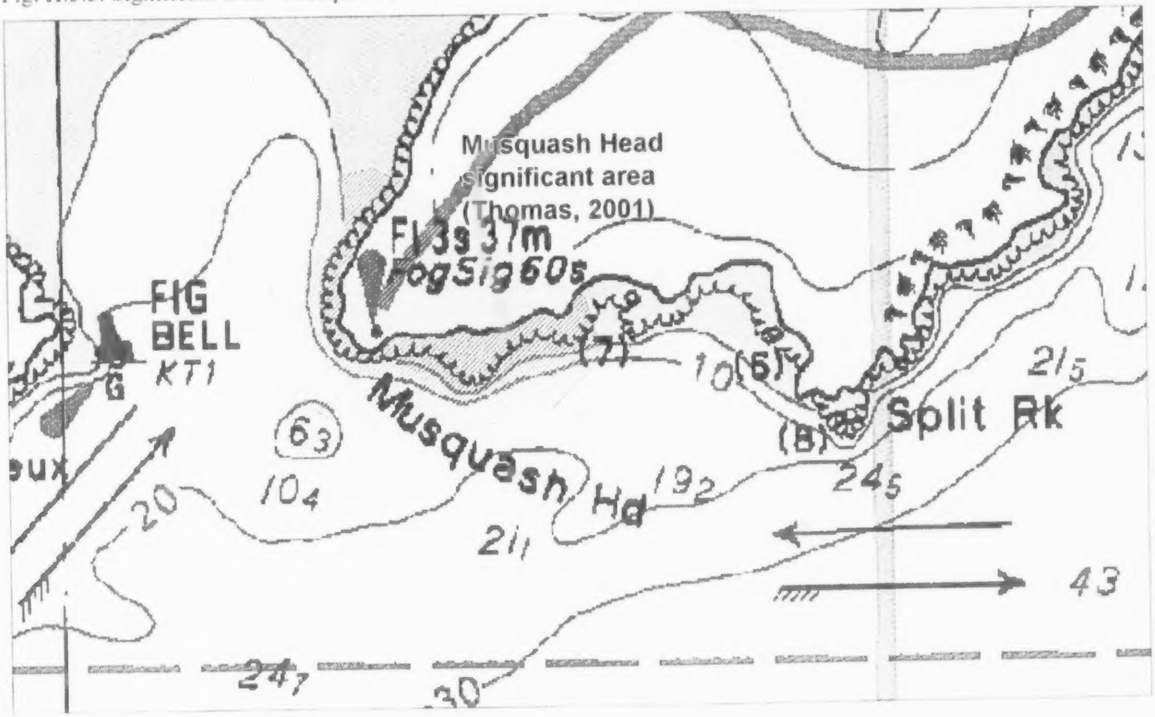

Musquash Head
significant area
(Thomas, 2001)
Fl 3s 37m
FogSig 60s
FIG
BELL
KT1
Musquash Hd
Split Rk

Fig. II.4. Areas of importance to semipalmated sandpipers.

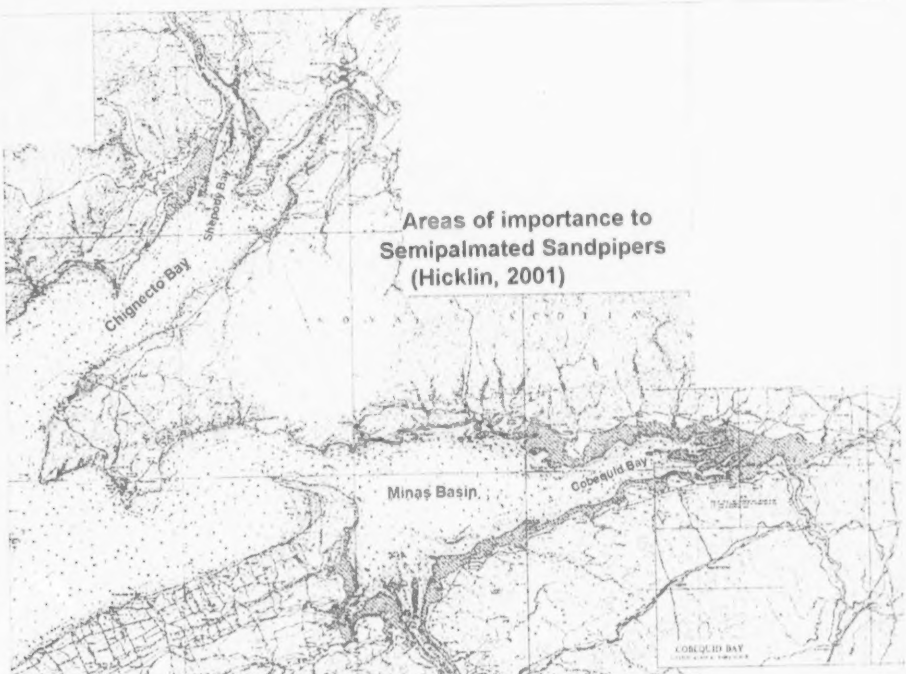

Areas of importance to
Semipalmated Sandpipers
(Hicklin, 2001)
Chignecto Bay
Shepody Bay
NOVA SCOTIA
Minas Basin
Cobequid Bay
COBEQUID BAY

Fig. II.5. Areas around which land acquisitions are being pursued by Eastern Habitat Joint Venture (EHJV).

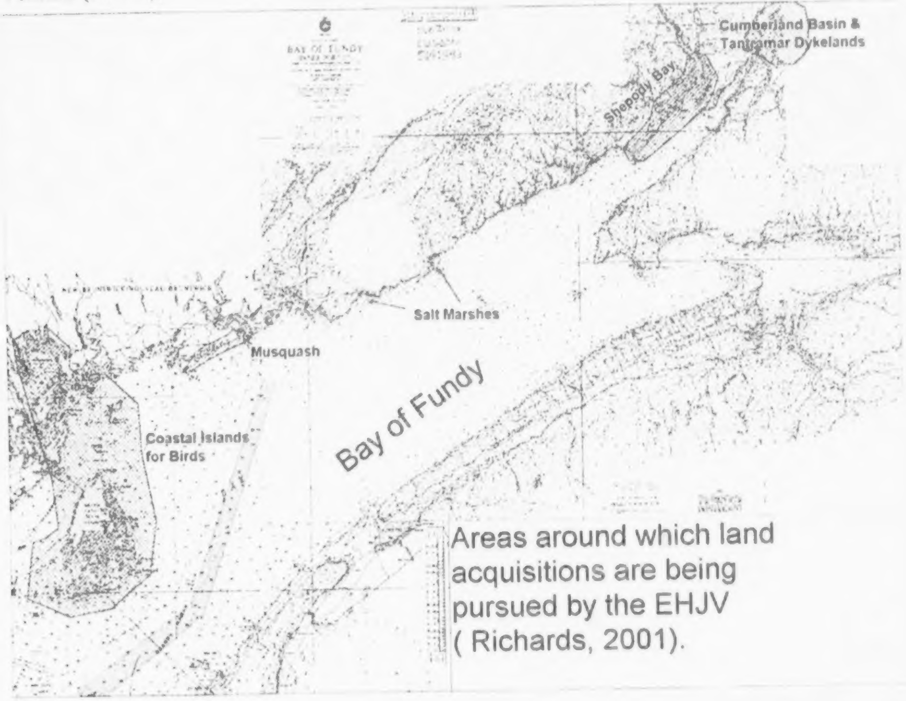
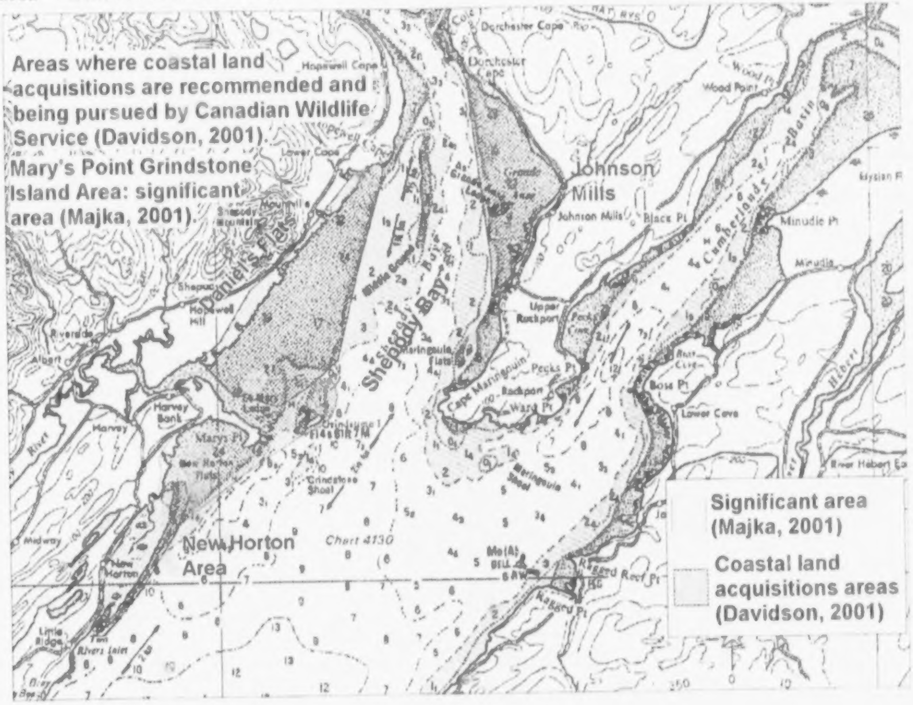

BAY OF FUNDY
Cumberland Basin &
Tantramar Dykelands
Shepody Bay
Salt Marshes
Musquash
Coastal Islands
for Birds
Bay of Fundy
Areas around which land
acquisitions are being
pursued by the EHJV
(Richards, 2001).

Fig. II.6. Areas of Canadian Wildlife Services (CWS) coastal land acquisitions and significant area - Grindstone Island area.


Areas where coastal land acquisitions are recommended and being pursued by Canadian Wildlife Service (Davidson, 2001).
Mary's Point Grindstone Island Area: significant area (Majka, 2001).
Johnson Mills
New Horton Area
Shepody Bay
Daniel's Flats
Dorchester Cape
Hopewell Cape
Lower Cape
Wood Point
Johnson Mills
Black Pt
Minudie Pt
Cumberland Basin
Upper Rockport
Cape Maringouin
Rockport
Ward Pt
Pecks Pt
Boss Pt
Lower Cove
Ragged Reef Pt
Ragged Pt
Maringouin Shoal
Grindstone Shoal
Grindstone I
Marys Pt
Harvey Bank
Harvey
Hopewell Hill
Riverside
Albert
New Horton
Little Ridge
Rivers Inlet
Midway
Chart 4130
River Hebert
Significant area (Majka, 2001)
Coastal land acquisitions areas (Davidson, 2001)